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EXPERIMENTAL 'A' AND 'AAR' WHEEL PROFILE MEASUREMENTS ON A CP UNIT COAL TRAIN FINAL REPORT

TP 5081 E

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Department of Research
Canadian Pacific Limited
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"The contents of this report reflect the views of the contractor and not necessarily the official views or policies of the Transportation Development Centre of Transport Canada."

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17. Abstract

Four bathtub coal cars, three equipped with 'A' profile and one with 'AAR' profile wheels were monitored for wheel wear to evaluate unit coal train wheel wear under typical CP Rail operating conditions. All cars were equipped with Barber S2-C trucks and WABCOPAC brakes with the exception of one car with brakes cut-out in order to establish the wheel wear pattern arising from wheel/rail interaction only. CP Rail wheel profilometers were used to collect wheel profile data on the four coal cars.

The findings indicate that the 'AAR' profile wheels exhibit higher flange and tread wear as compared to 'A' profile wheels. Both 'A' and 'AAR' wheels attain a common worn profile, but the 'A' profile wheel stabilizes faster in the flange throat region. Based on a single point measurement, the car with no brakes experienced more tread wear as compared to the cars with brakes.

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17. Résumé

Quatre wagons-trémies utilisés pour le transport du charbon, dont trois d'entre eux équipés de roues à profil de type A et un de type AAR, ont fait l'objet d'un contrôle suivi visant à évaluer l'usure des roues dans des conditions de service propres à CP Rail. Ces wagons avaient été équipés de bogies Barber S2-C ainsi que de freins WABCOPAC, à l'exception d'un wagon qui avait été laissé sans frein afin de pouvoir étudier le profil d'usure dû à la seule interaction roue-rail. Les données sur l'usure des roues de ces quatre wagons ont été obtenues grâce à des profilomètres du CP Rail.

L'étude de ces données a fait ressortir que l'usure du boudin et du cercle de roulement est plus forte sur les roues à profil AAR que sur celles à profil A et que, si ces deux types de roues finissent par montrer le même profil d'usure, c'est sur les roues de type A que le profil d'équilibre est le plus rapidement atteint dans la zone roue-boudin. Quant au wagon sans frein, les mesures effectuées en un point unique des roues montrent une usure du cercle de roulement plus prononcée que celle des roues soumises à l'action des freins.

18. Mots-clés	19. Diffusion
Profils de roue A et AAR, profilomètre, interaction roue-rail, profil d'usure	Le CDT dispose d'un nombre limité d'exemplaires

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EXECUTIVE SUMMARY

The Research Department of Canadian Pacific undertook a comparative wheel profile monitoring test program to evaluate unit coal train wheel wear under typical CP Rail operating conditions. The primary objective was a comparative study of wear patterns of 'A' and 'AAR' profile wheels. An assessment of the effects of braking and application of C-Pep on wheel wear were secondary test objectives.

The Research Department's wheel profilometers were used to collect wheel profile data on four coal cars. The four cars utilized during the test period were CP 351315, CP 351308, CP 351785 and CP 351505. All cars were equipped with Barber S2-C trucks and WABCOPAC brakes with the exception of car CP 351308 which had the brakes cut-out in order to establish the wheel wear pattern arising from wheel/rail interaction only. The various combinations of the test car features were as follows:

CP 351315	'A' profile, brake	CP 351785	'AAR' profile, brake
CP 351308	'A' profile, no brake	CP 351505	'A' profile, brake, C-Pep

An interim report was issued in July 1980 to summarize the results obtained from measurements to 44,470 miles. This report presents the results obtained from subsequent measurements to approximately 200,000 miles of revenue service operation.

Test car CP 351785 with 'AAR' profile wheels exhibited higher flange and tread wear as compared to test car CP 351315 equipped with 'A' profile wheels. The flange wear rate of the 'AAR' profile wheel is higher up to 44,000 miles after which both 'A' and 'AAR' profile wheels attain the same wear rate, after the initial 'break-in' period.

Based on a single point measurement, the car with no brakes experienced more tread wear as compared to the cars which operated with brakes. Tread wear was measured only at one location, 2 7/8" from the back face of the wheels, therefore it was not possible to determine the amount of

total tread metal loss. No definitive conclusions can be made concerning the effect of braking on tread area wear or metal loss. It was observed from the plotted worn wheel profiles, however, that brakes do assist wheels to develop a more even tread wear pattern.

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1. INTRODUCTION

The Research Department of Canadian Pacific undertook a wheel profile monitoring test program to evaluate unit coal train wheel wear under typical CP Rail operating conditions. Four 100-ton bathtub coal cars equipped with Barber S2-C trucks were fitted with two wear, 36 inch diameter, class C wide flange wrought wheels.

The four cars utilized during the test period were CP 351315, CP 351308, CP 351785 and CP 351505. All test cars with the exception of CP 351785, which was provided with AAR profile wheels, were equipped with 'A' profile wheels. All cars had CP standard WABCOPAC brakes with the exception of car CP 351308 which had the brakes cut-out in order to establish the wheel wear pattern arising from wheel/rail interaction only. Car CP 351505 was the only test car equipped with centre plate extension pads (C-Pep). The various combinations of test car features are as follows:

CP 351315	'A' profile, brake	CP 351785	'AAR' profile, brake
CP 351308	'A' profile, no brake	CP 351505	'A' profile, brake, C-Pep

The test cars were placed in unit train service operating in the Pacific Region. Profile measurements were taken prior to releasing cars for revenue service. During the test period wheel profiles were taken at 1,720, 3,180, 8,750, 44,470, 67,000, 94,000 and 203,000 miles. These measurements were taken in Revelstoke, B.C., and Ogden Shops in Calgary during the period between September 1979 and September 1982. The results are summarized in Tables 1 and 2.

An interim report entitled "Experimental and AAR Wheel Profile Measurements on a CP Unit Coal Train" was issued in July 1980 to summarize the results obtained from measurements to 44,470 miles. The present report discusses these and subsequent measurements and is intended as a final report on this phase of the test program.

2. WHEEL PROFILOMETER

Initial wheel profile measurements were taken using the CP Research Department's original profilometer which is an electro-mechanical device which collects and stores measured wheel profile digital data. The data were computer processed and plotted and wear data were obtained by graphical matching.

As an improved wheel profilometer later became available, the last set of wheel profile measurements was carried out with the new profilometer. Although this profilometer is capable of processing wear data automatically through the computer, it was not possible to do so because of the unavailability of initial wheel profiles in a format suitable for acceptance to the computer software of the new profilometer.

To calculate flange wear and tread wear data, use was made of available normal 'AAR' and 'A' profile data. It is worthwhile mentioning here that not all data extracted from the wheel profile measurements collected by the original profilometer were used. The reason for this is that it was not always possible to manually match wheel profiles when excessive flange and tread wear occurred.

3. TESTS RESULTS

3.1 Discussion of Final Wheel Profile Measurements

Wheel profiles collected after approximately 200,000 miles of revenue service operation are shown in the Appendix. Table 3 also summarizes the condition of test cars in terms of the number of original wheelsets remaining in service after 200,000 miles of operation.

As can be seen from the plotted wheel profiles, test car CP 351308 which had inoperative brakes developed a peculiar wheel wear pattern. Most significant is the hollowness in the tread area observed particularly

on the left wheel of axle number 3. The excessive hollowness was initially observed after 44,470 miles of service.

In general, the test car equipped with 'AAR' profile wheels exhibited larger flange and tread wear as compared to test cars equipped with 'A' profile wheels. The car with inoperative brakes also experienced a large amount of flange and tread wear particularly on axles 2 and 3. The flange wear on wheels of these axles was also uneven, wear on axle 3 wheels being higher on the left hand wheel as compared to the right hand wheel. The opposite was true for wear of wheels on axle 2. Wheels on axles 1 and 4 on this car experienced more even wear. Even wear on all wheels is expected because these cars operate about 6 months in one direction and then are turned. The reason why the wear on the inner axle wheels were uneven is not known. A possible explanation for this was given in the previous report as being a small initial diameter mismatch that may have caused lateral tracking of these axles to one side.

A number of wheelsets were changed during the test period due to shelling. A summary of the number of wheelsets changed out and the accumulated mileage for each is shown in Table 3. Three of the 4 wheelsets on car CP 351505 equipped with 'A' profile wheels and C-Pep were changed out at mileages between 103,000 miles and 154,000.

Car CP 351785 equipped with 'AAR' profile wheels exhibited relatively more wheel wear but had only one wheelset changed out due to shelling at 135,000 miles. Car CP 351308 equipped with 'A' profile wheels but no brakes performed best in terms of wheel change outs. None of its wheelsets were removed because of shelling or other defects.

The other interesting observation which was made was that, based on a single point measurement, the car with no brakes experienced more tread wear as compared to the cars which operated with normal brakes. The tread wear was measured at a point 2 7/8" from the back face of wheels

and therefore it was not possible to determine the amount of total tread metal loss. Hence, no definite conclusions can be made concerning the effect of braking on tread area wear or metal loss. It does appear however that brakes do assist wheels in developing more even tread wear pattern.

3.2 FLANGE WEAR

Data for flange wear of the 4 test cars were obtained and plotted as a function of service mileage as shown in Figure 1. The data points for measurements up to 44,470 miles were obtained from values previously reported and other values calculated as the maximum wear experienced by the wheel flanges. In arriving at an average maximum flange wear value, all wheel flanges of the car were taken into account.

It can be easily seen that the rate of flange wear of the 'A' profile wheel is lower than the 'AAR' up to about 44,000 miles. After that the wear rates are similar as the slopes of both lines are parallel (except for the car with no brakes). These results are very similar to results obtained by CN Rail utilizing a larger sample of test cars (25 car population).

3.3 TREAD WEAR

Figure 2 shows the plot of the increase in flange height versus service mileage accumulated for each car. As can be seen there is an appreciable difference between the tread wear rates of 'AAR' profile and 'A' profile wheels. Car CP 351785 equipped with 'AAR' profile wheel sustained more tread wear than the other three cars with 'A' profile wheels.

As mentioned previously, the car with no brakes experienced more tread wear due to excessive hollowness developed on the wheel tread surfaces. However, this was based on a single point measurement and therefore is not possible to elaborate on the total amount of tread metal loss.

CONCLUSIONS

1. Flange wear data indicate that the wear of 'AAR' profile wheels is higher than that of the 'A' profile wheels. The wear rate is higher to approximately 44,000 miles after which both 'A' and 'AAR' profile wheel flange wear rates become similar.

2. Tread wear data showed that the 'AAR' profile wheel had greater tread wear than the 'A' profile both in the initial 'break-in' period and during subsequent service.

3. Both 'A' and 'AAR' profile wheels attain a common worn profile, but the 'A' profile wheel stabilizes faster in the flange throat region.

4. Based on a single point measurement, the car with inoperative brakes experienced more tread wear as compared to the car which operated with normal brakes. As tread wear measurements were taken at one point 2 7/8" from the back face of wheels, no definitive conclusion can be made concerning the effect of braking on tread area wear.

5. It was observed that brakes assist wheels to develop a more even tread wear pattern.

Car Number	Test Wheel Profile	Brake Type	Average Maximum Flange Wear in mms (inches) 8,750 Miles	44,470 Miles	67,000 Miles	94,000 Miles	203,000 Miles
CP 351315	'A' Profile	Wabcopac	1.275(.050")	2.485(.098")	3.045(.120")	-	5.5[2](.216")
CP 351308	'A' Profile	No brakes	1.475(.058")	2.700(.106")	3.735(.147")	4.53(.178")	7.75[3](.305")
CP 351785	'AAR' Profile	Wabcopac	2.005(0.079)	3.650(.143")	-	-	6.66[4](.262")
CP 351505	'A' Profile	Wabcopac[1]	1.385(.054")	2.605(.102")	3.295(.129")	-	-

TABLE 1: WHEEL FLANGE WEAR MEASUREMENTS ON FOUR BATHTUB COAL CARS

Notes 1: CP 351505 was also equipped with C-Pep
2: Average flange wear shown is only for wheelsets 1 and 3.
3: Average flange wear shown is for all wheelsets.
4: Average flange wear shown is for wheelsets 1, 3 and 4.

Car Number	Test Wheel Profile	Brake Type	Tread Wear in mms (inches) 8,750 Miles	44,470 Miles	67,000 Miles	94,000 Miles	203,000 Miles
CP 351315	'A' Profile	Wabcopac	.18(.007")	.45(.018")	.645(.025")	1.005(.039")	1.95[2](.077")
CP 351308	'A' Profile	No Brakes	.18(.007")	.78(.031")	.955(.038")	1.325(.052")	2.33[3](.091")
CP 351785	'AAR' Profile	Wabcopac	.39(.015")	.885(.035")	-	-	3.13[4](.123")
CP 351505	'A' Profile	Wabcopac[1]	.195(.008")	.74(.029")	.93(.037")	-	-

TABLE 2: WHEEL TREAD WEAR MEASUREMENTS ON FOUR BATHTUB COAL CARS

Notes:
1 - CP 351505 was also equipped with C-Pep.
2 - Average tread wear shown is only for wheelsets 1 & 3.
3 - Average tread wear shown is for all wheels.
4 - Average tread wear shown is for wheelsets 1, 3 & 4.

Test Car	Car Number	Wheel Profile	Special Features	Mileage Accumulated	Wheels Changed Out During Test Period	Mileage at Wheel Changeout
1	CP 351315	'A' Profile	Wabcopac Brakes	203,000 Miles	Axle 2 Axle 4	Axle 2 - 127,000 Miles Axle 4 - 127,000 Miles
2	CP 351308	'A' Profile	No brakes	203,000 Miles	None	
3	CP 351785	'AAR' Profile	Wabcopac Brakes	203,000 Miles	Axle 2	Axle 2 - 135,000 Miles
4	CP 351505	'A' Profile	Wabcopac Brake and C-Pep	180,000 Miles	Axle 4 Axle 3 Axle 1	Axle 4 - 103,000 Miles Axle 3 - 111,000 Miles Axle 1 - 154,000 Miles

TABLE 3: SUMMARY OF WHEEL CHANGEOUTS DURING TEST PERIOD

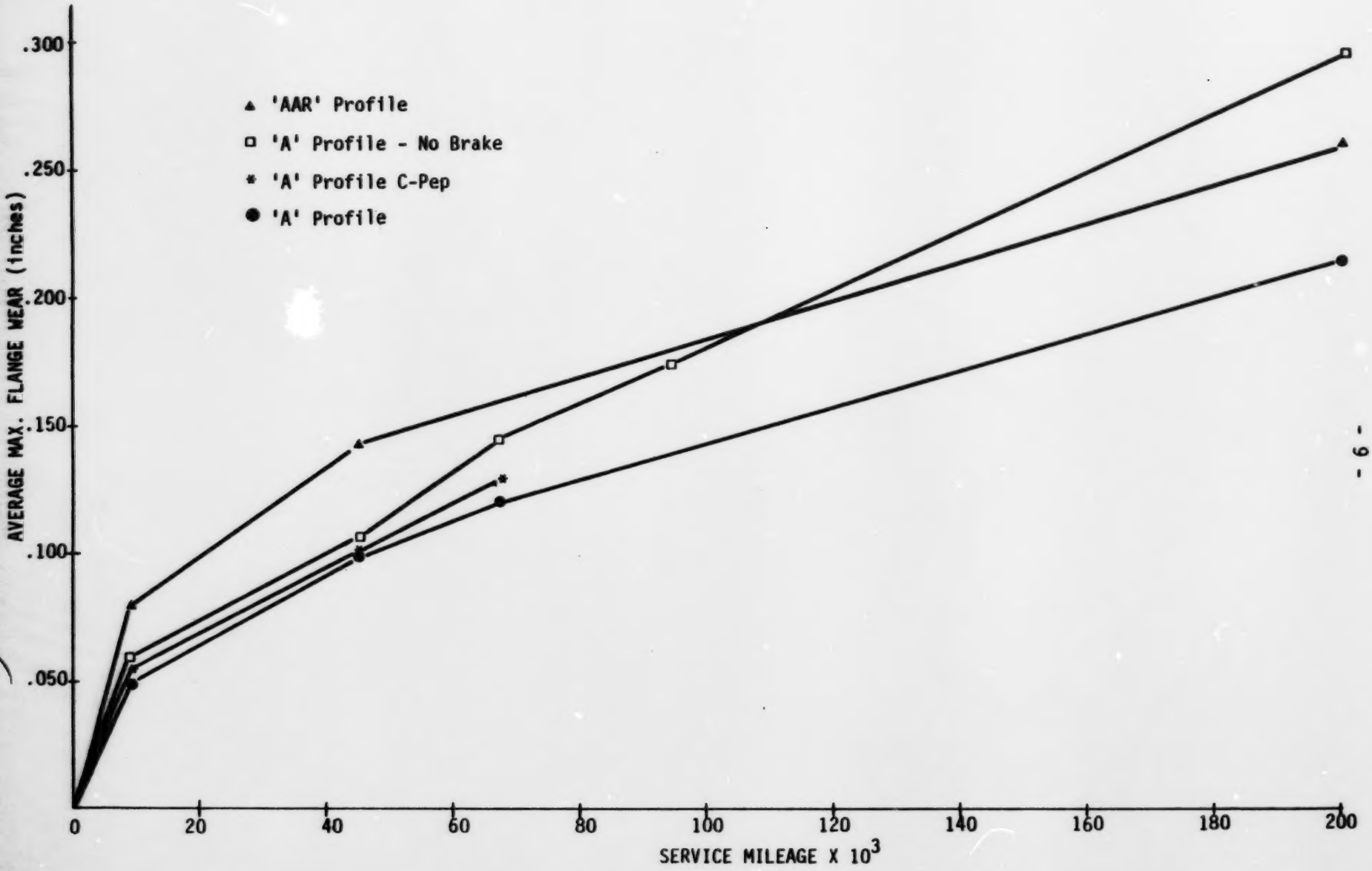

FIG. 1: AVERAGE MAX. FLANGE WEAR VS MILEAGE

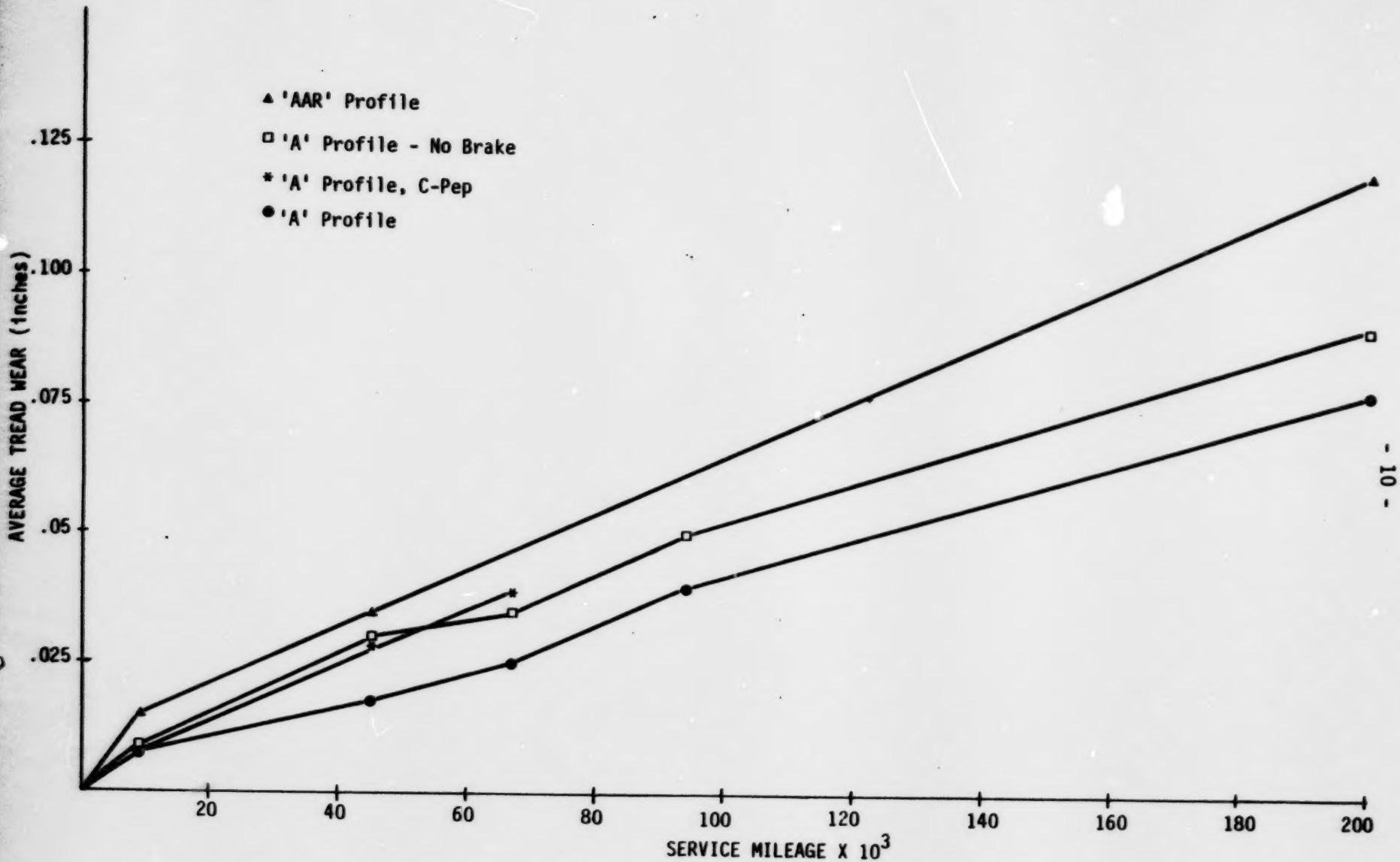

FIG. 2: AVERAGE TREAD WEAR VS SERVICE MILEAGE

APPENDIX

WHEEL PROFILES OF TEST CARS AFTER APPROXIMATELY 200,000 MILES OF REVENUE SERVICE OPERATION

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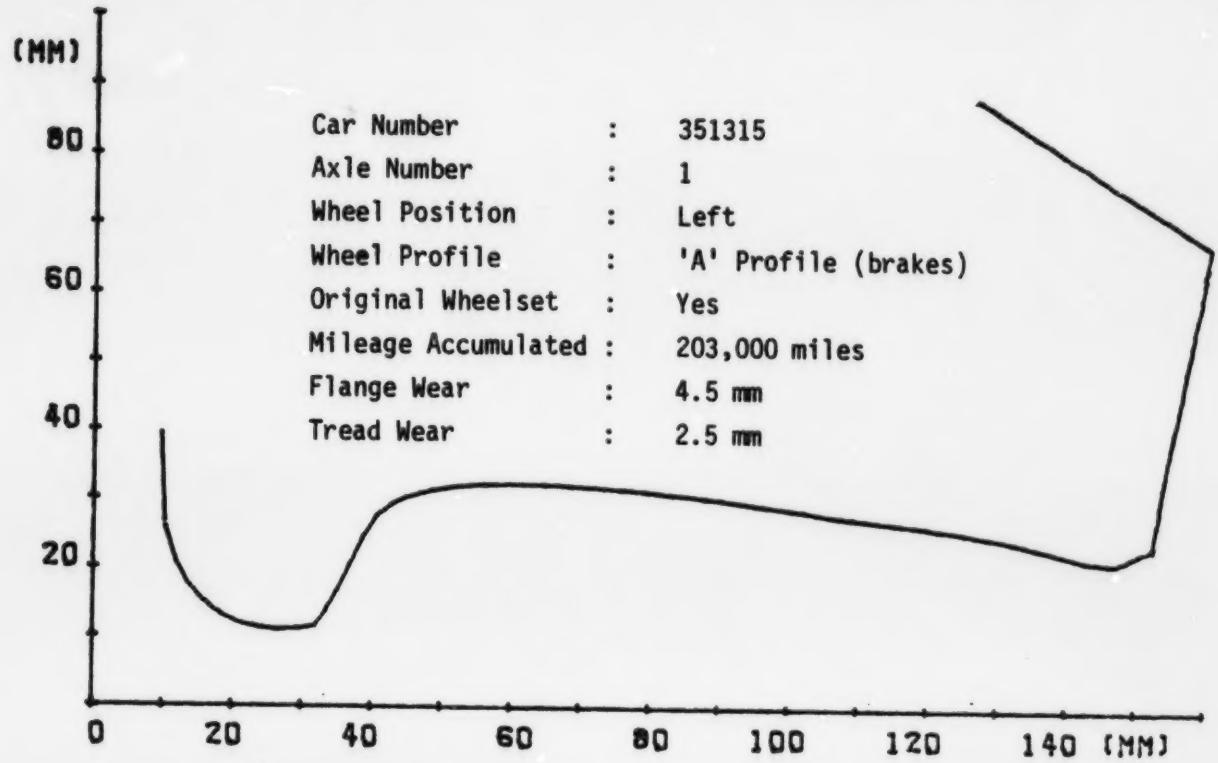

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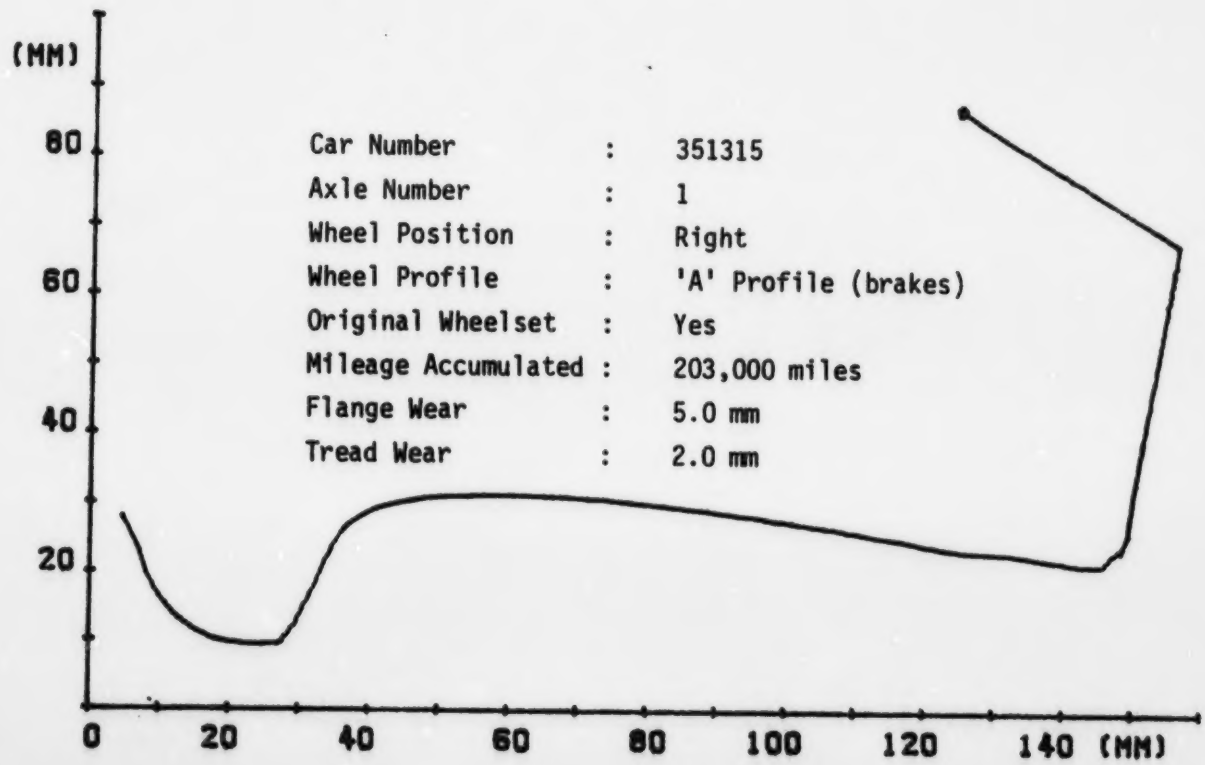

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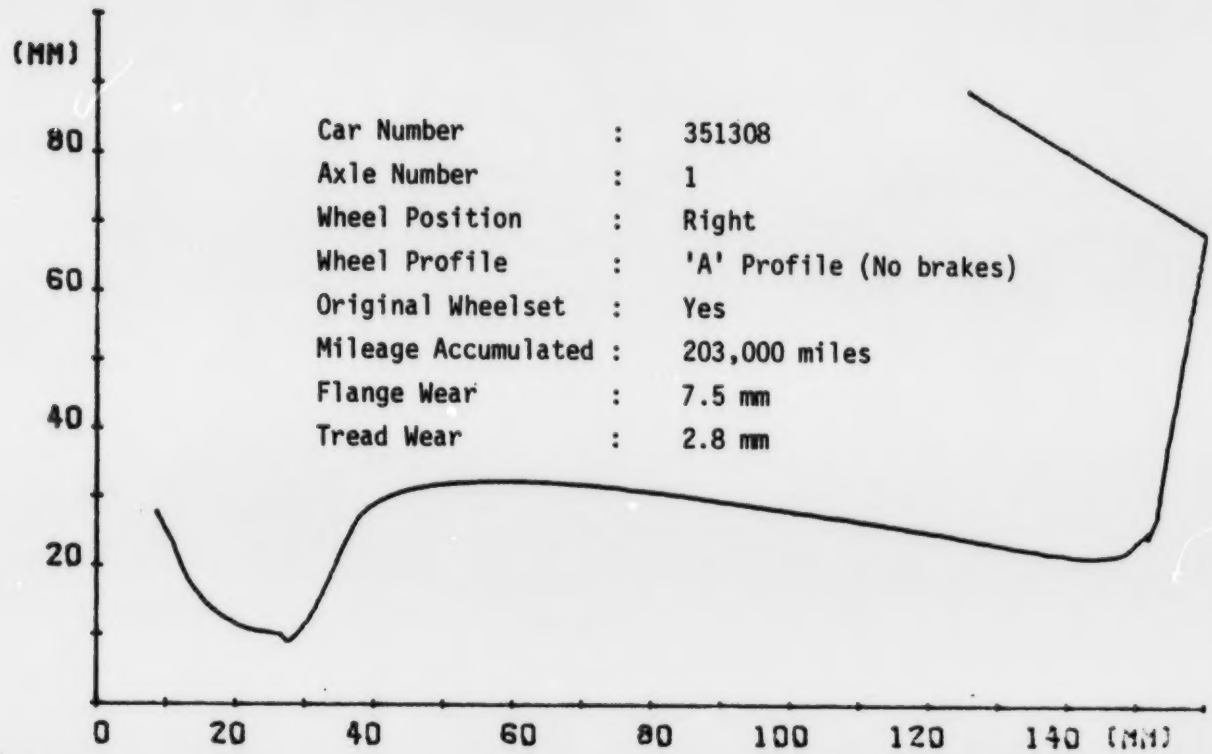

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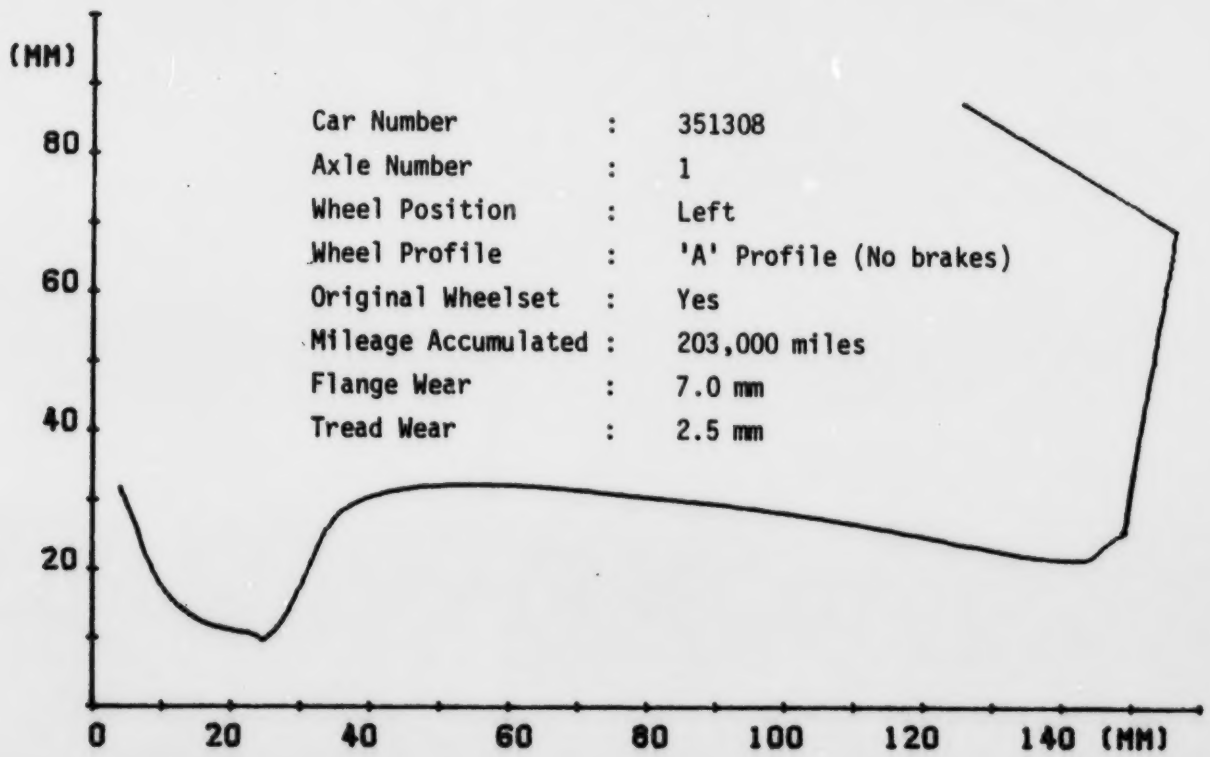

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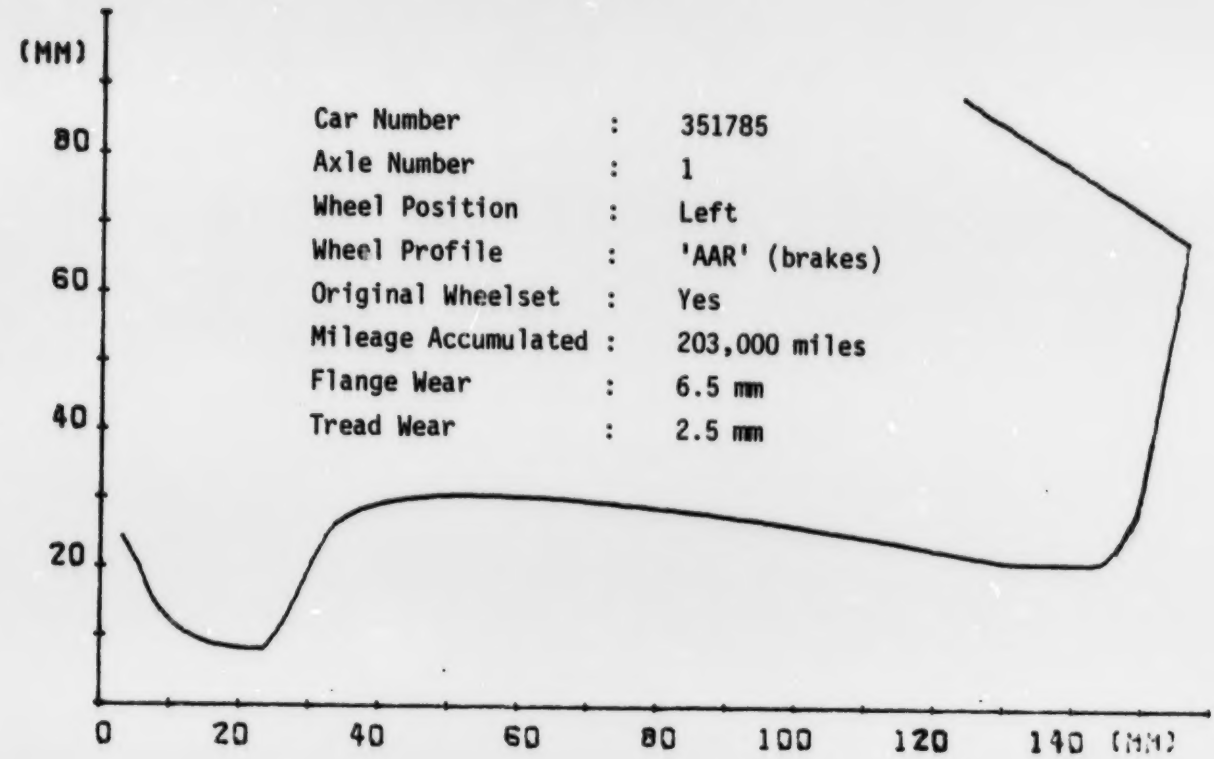

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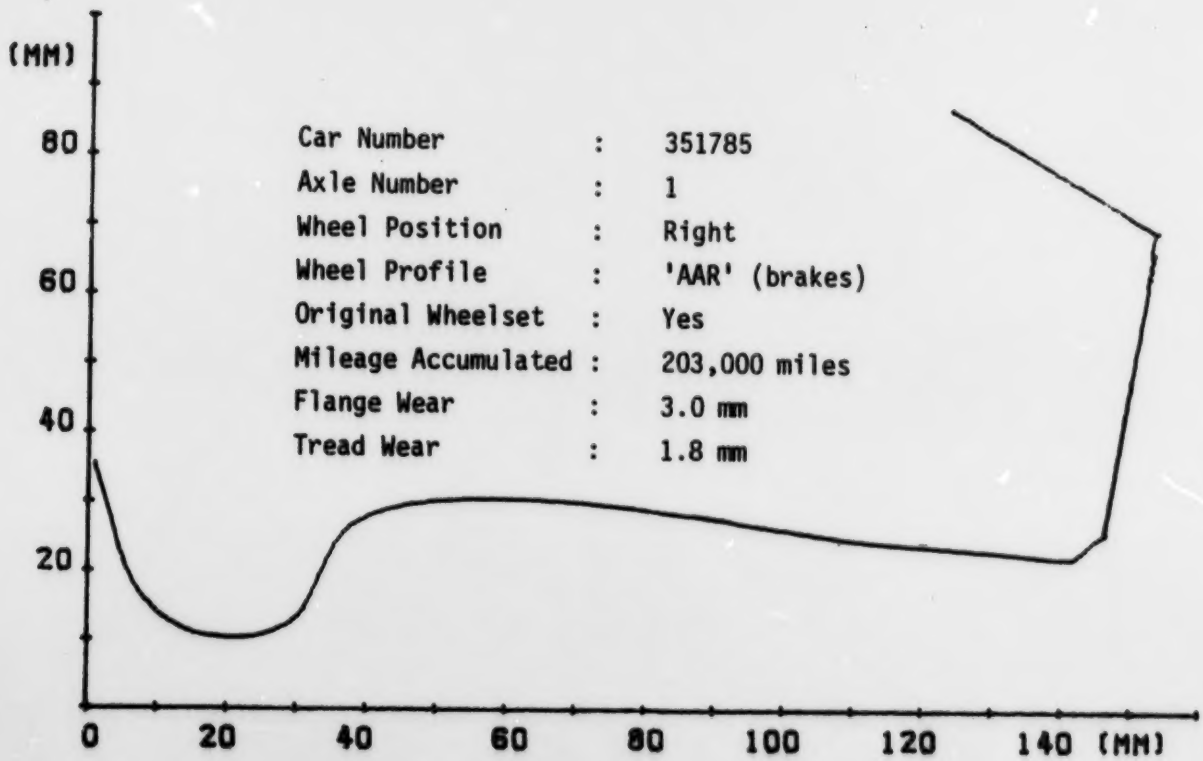

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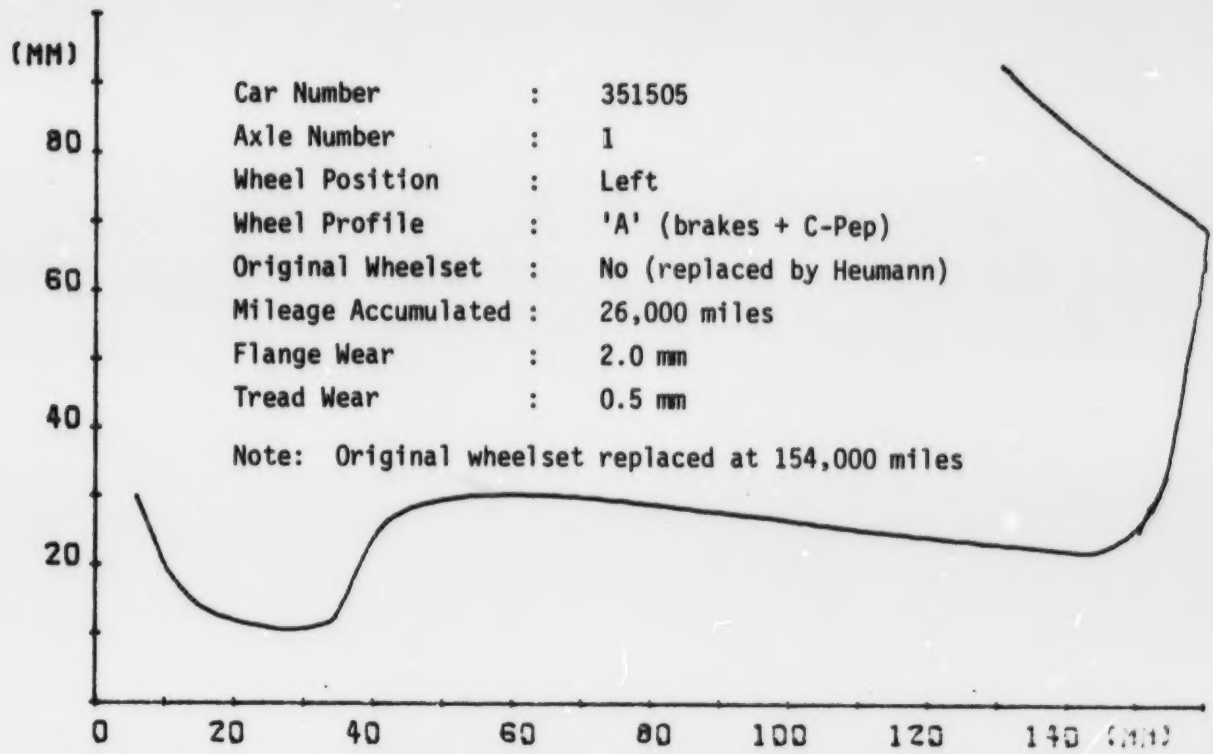

Car Number	:	351505
Axle Number	:	1
Wheel Position	:	Left
Wheel Profile	:	'A' (brakes + C-Pep)
Original Wheelset	:	No (replaced by Heumann)
Mileage Accumulated	:	26,000 miles
Flange Wear	:	2.0 mm
Tread Wear	:	0.5 mm

Note: Original wheelset replaced at 154,000 miles

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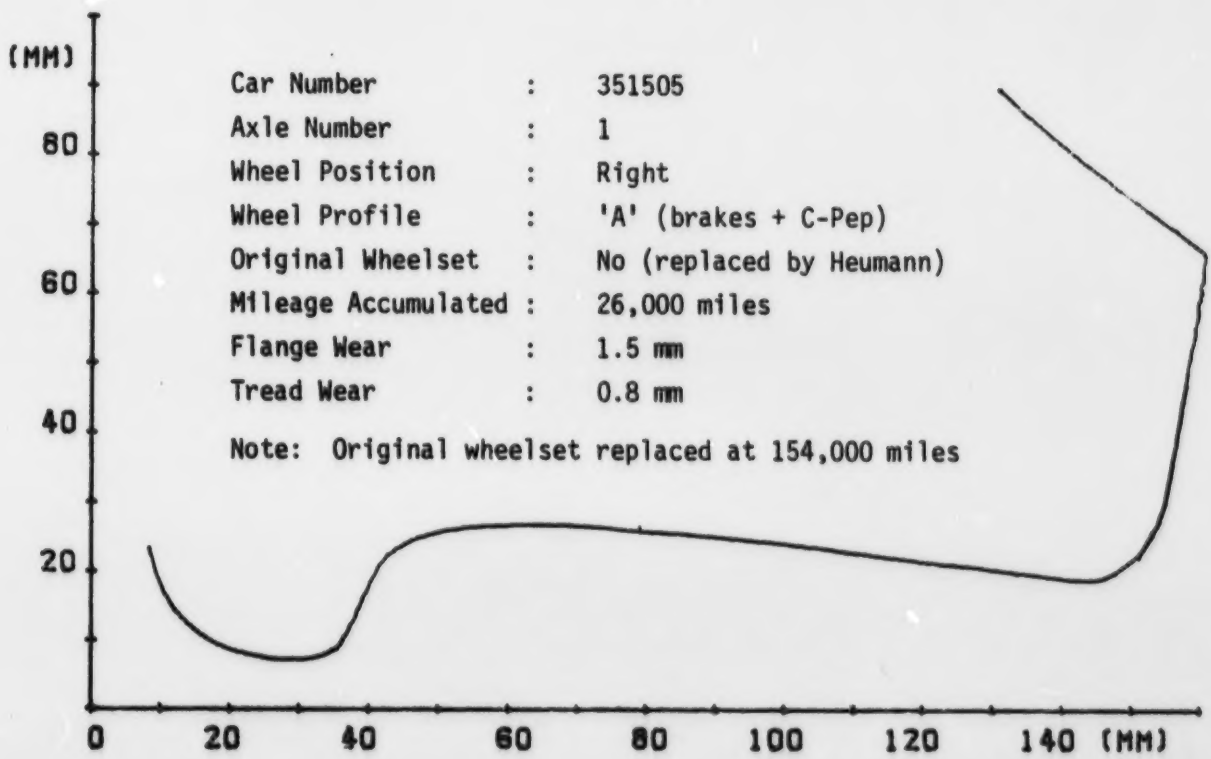

Car Number	:	351505
Axle Number	:	1
Wheel Position	:	Right
Wheel Profile	:	'A' (brakes + C-Pep)
Original Wheelset	:	No (replaced by Heumann)
Mileage Accumulated	:	26,000 miles
Flange Wear	:	1.5 mm
Tread Wear	:	0.8 mm

Note: Original wheelset replaced at 154,000 miles

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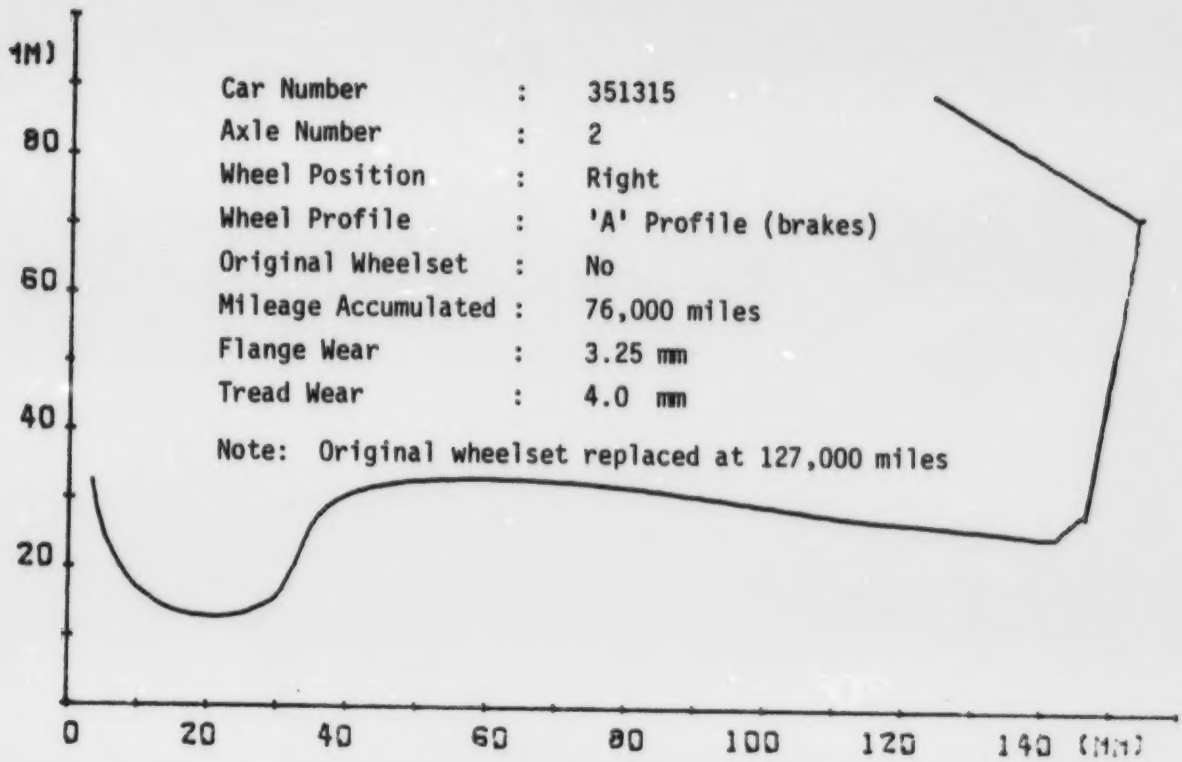

Car Number	:	351315
Axle Number	:	2
Wheel Position	:	Right
Wheel Profile	:	'A' Profile (brakes)
Original Wheelset	:	No
Mileage Accumulated	:	76,000 miles
Flange Wear	:	3.25 mm
Tread Wear	:	4.0 mm

Note: Original wheelset replaced at 127,000 miles

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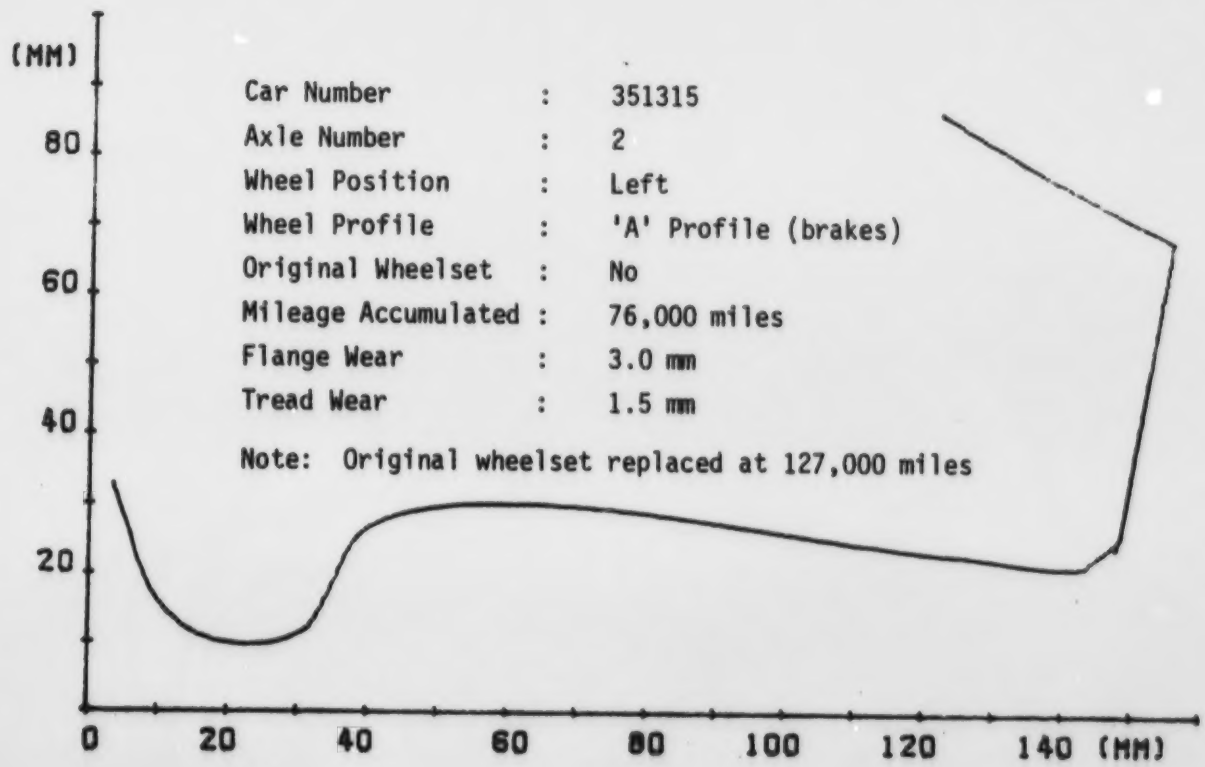

Car Number	:	351315
Axle Number	:	2
Wheel Position	:	Left
Wheel Profile	:	'A' Profile (brakes)
Original Wheelset	:	No
Mileage Accumulated	:	76,000 miles
Flange Wear	:	3.0 mm
Tread Wear	:	1.5 mm

Note: Original wheelset replaced at 127,000 miles

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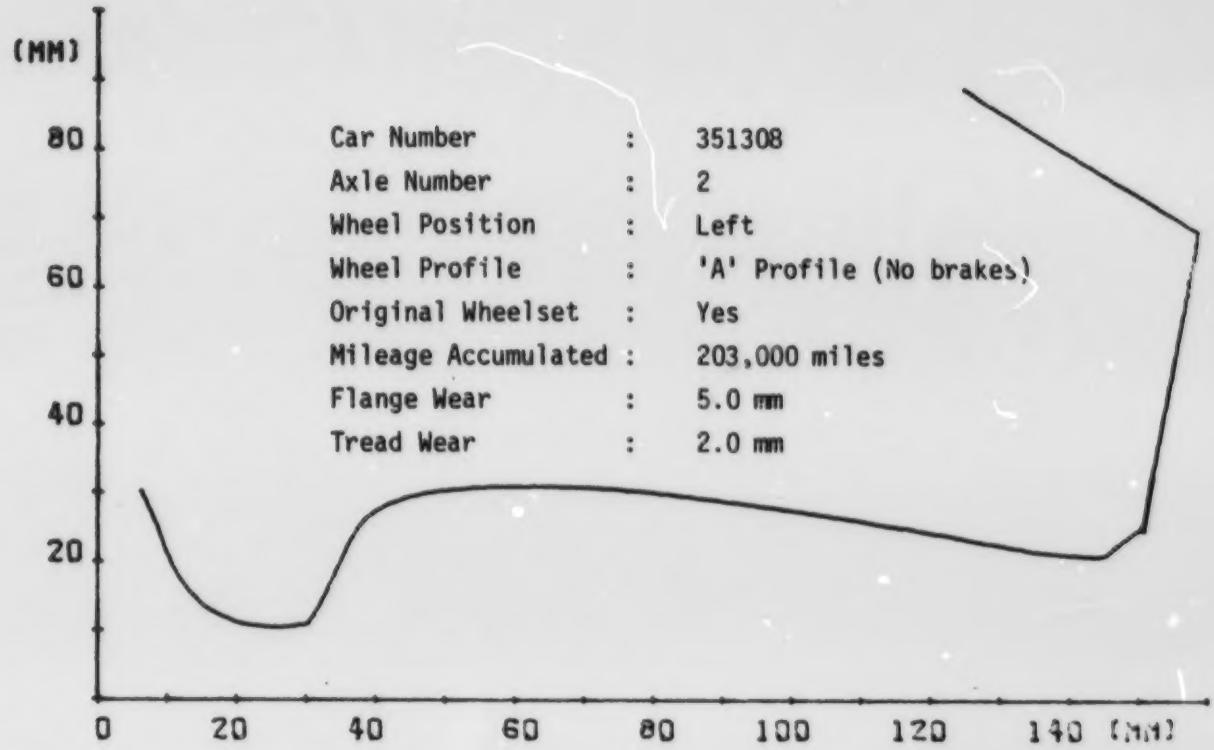

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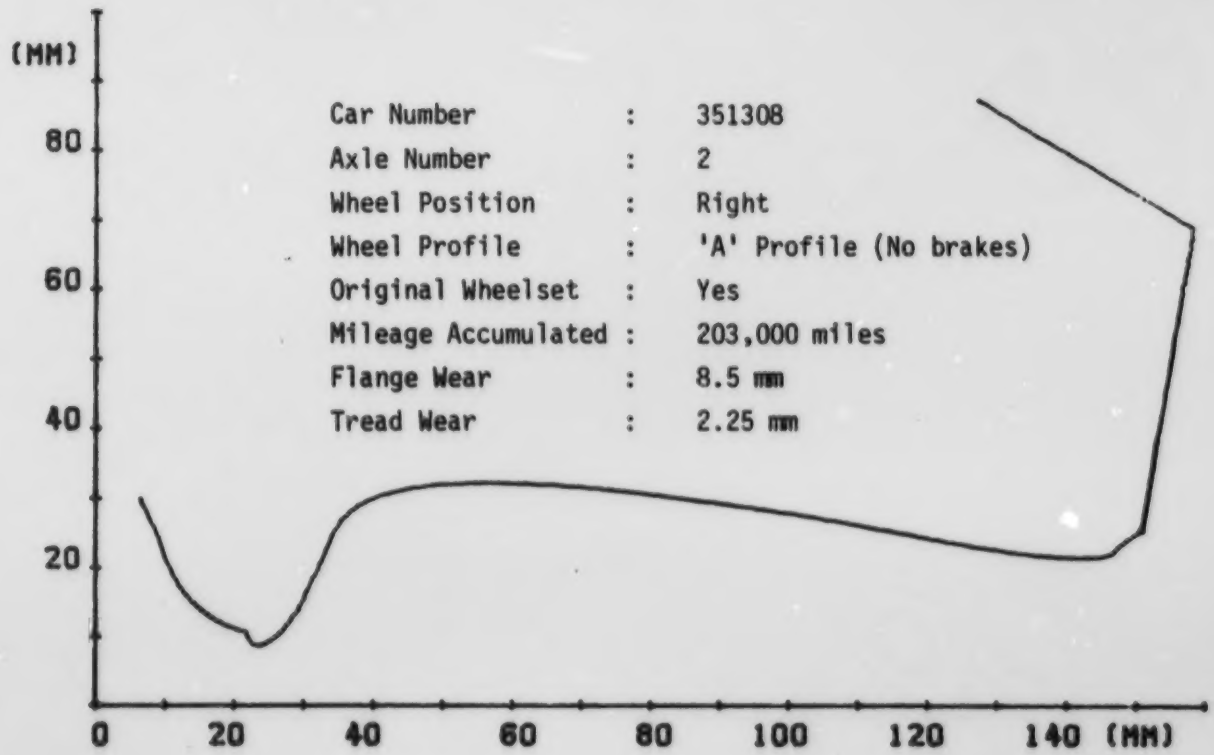

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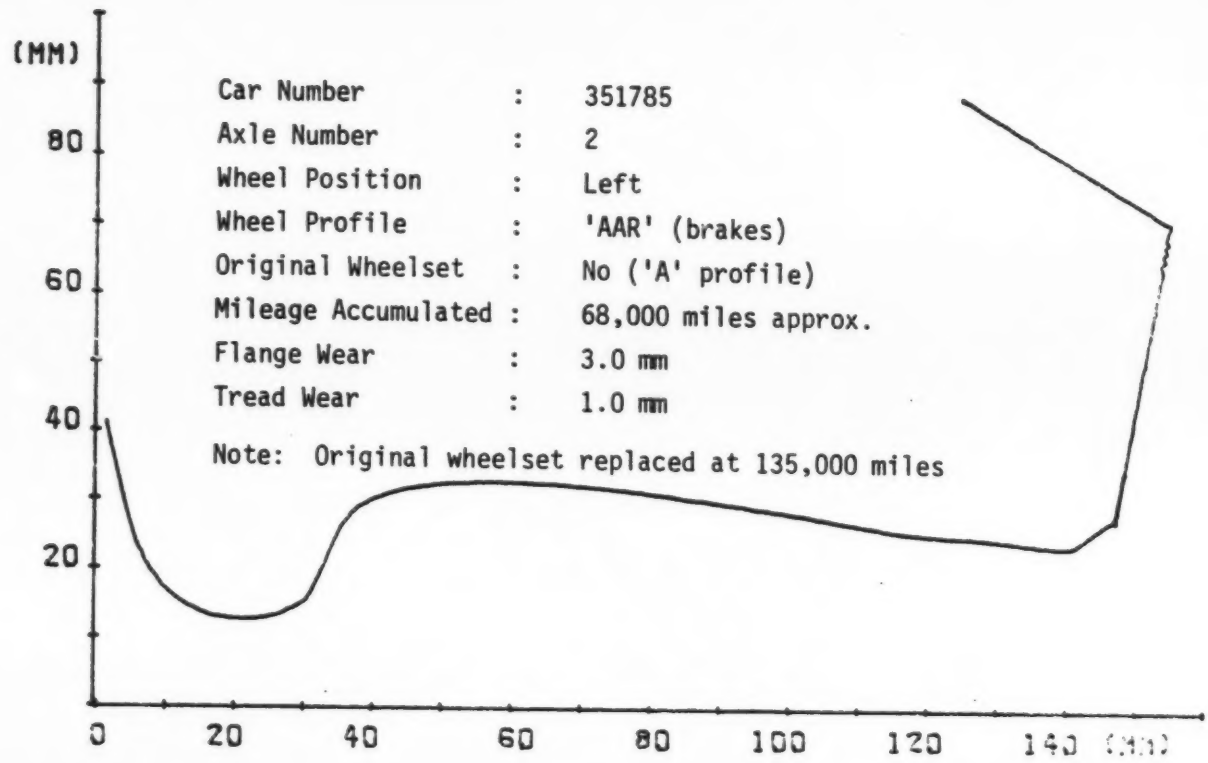

Car Number	:	351785
Axle Number	:	2
Wheel Position	:	Left
Wheel Profile	:	'AAR' (brakes)
Original Wheelset	:	No ('A' profile)
Mileage Accumulated	:	68,000 miles approx.
Flange Wear	:	3.0 mm
Tread Wear	:	1.0 mm

Note: Original wheelset replaced at 135,000 miles

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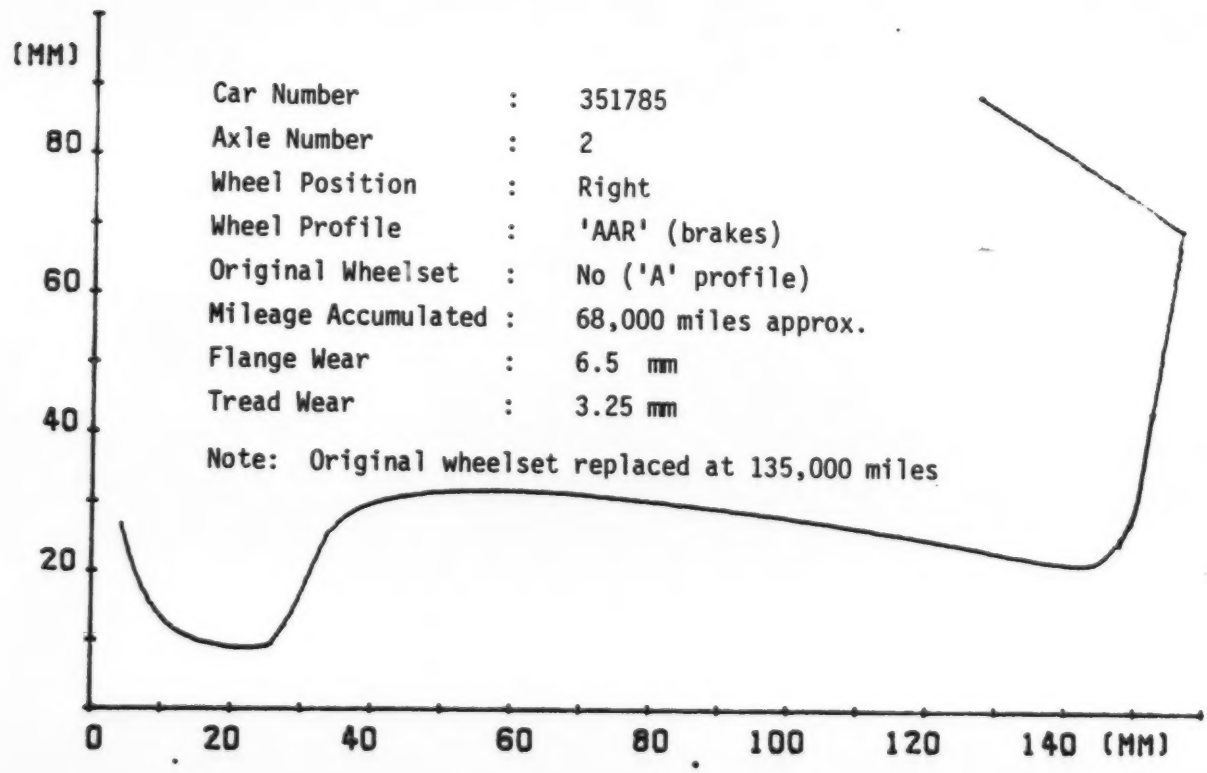
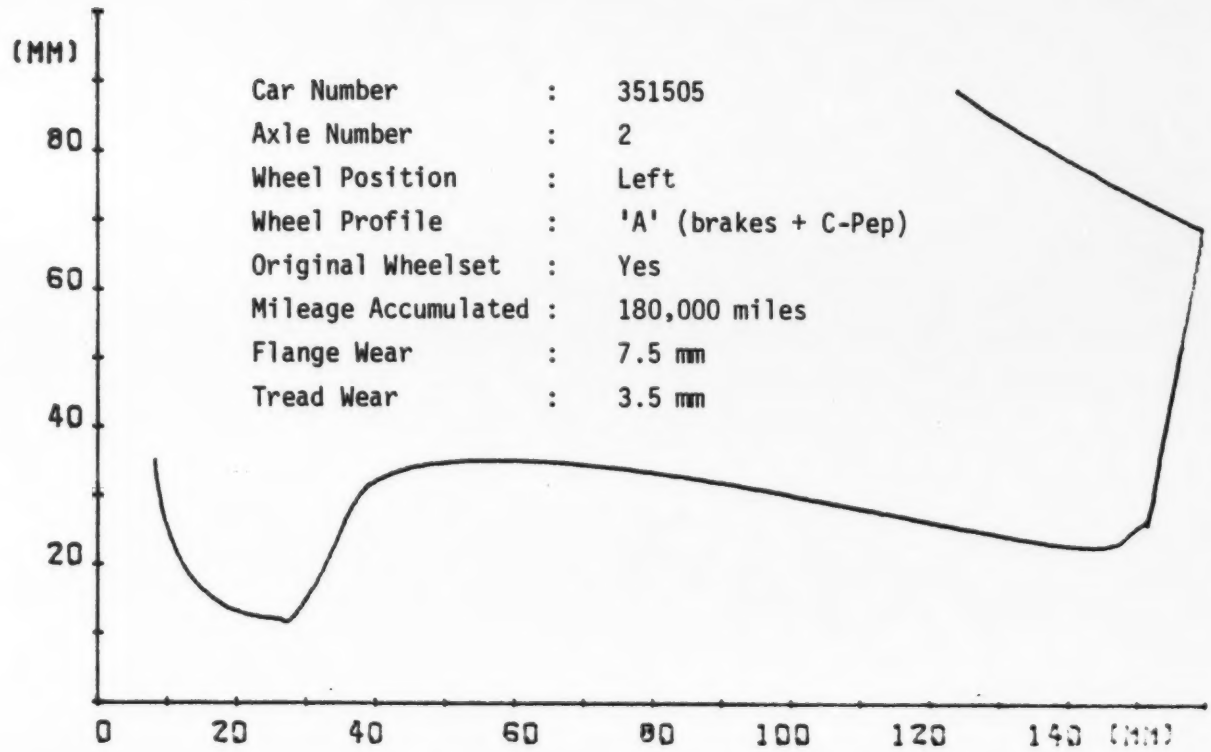


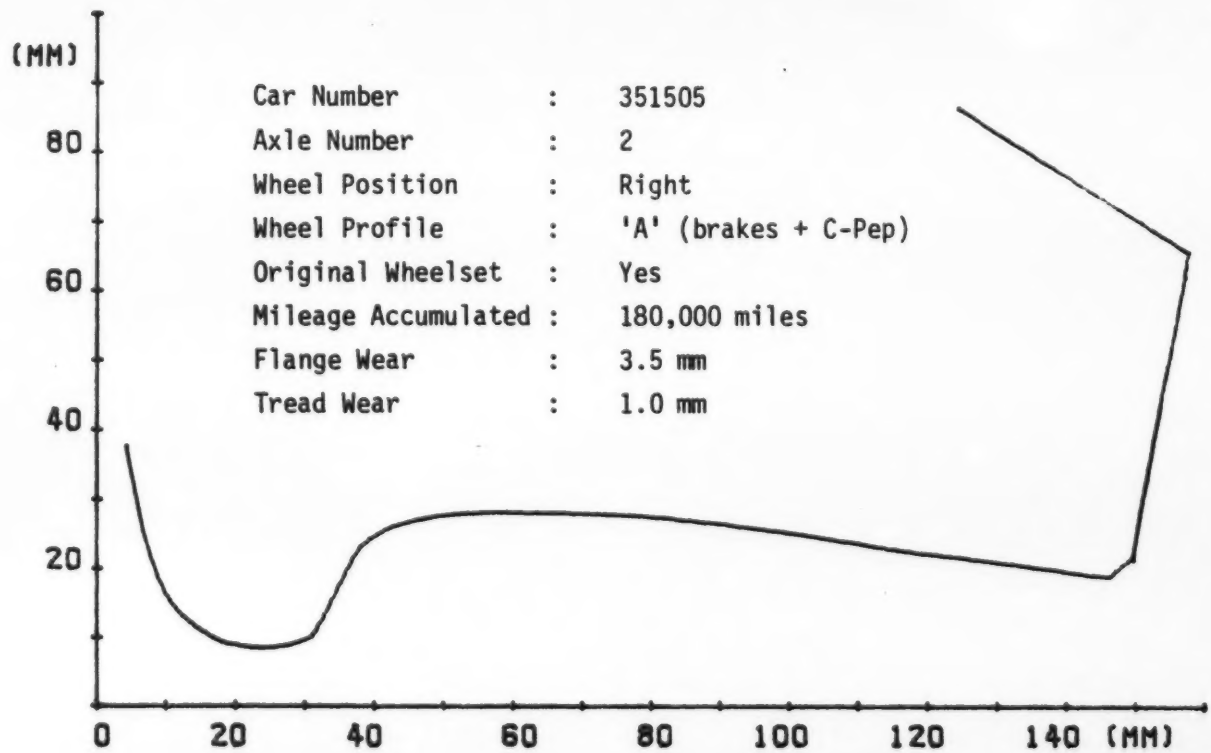
Car Number	:	351785
Axle Number	:	2
Wheel Position	:	Right
Wheel Profile	:	'AAR' (brakes)
Original Wheelset	:	No ('A' profile)
Mileage Accumulated	:	68,000 miles approx.
Flange Wear	:	6.5 mm
Tread Wear	:	3.25 mm

Note: Original wheelset replaced at 135,000 miles

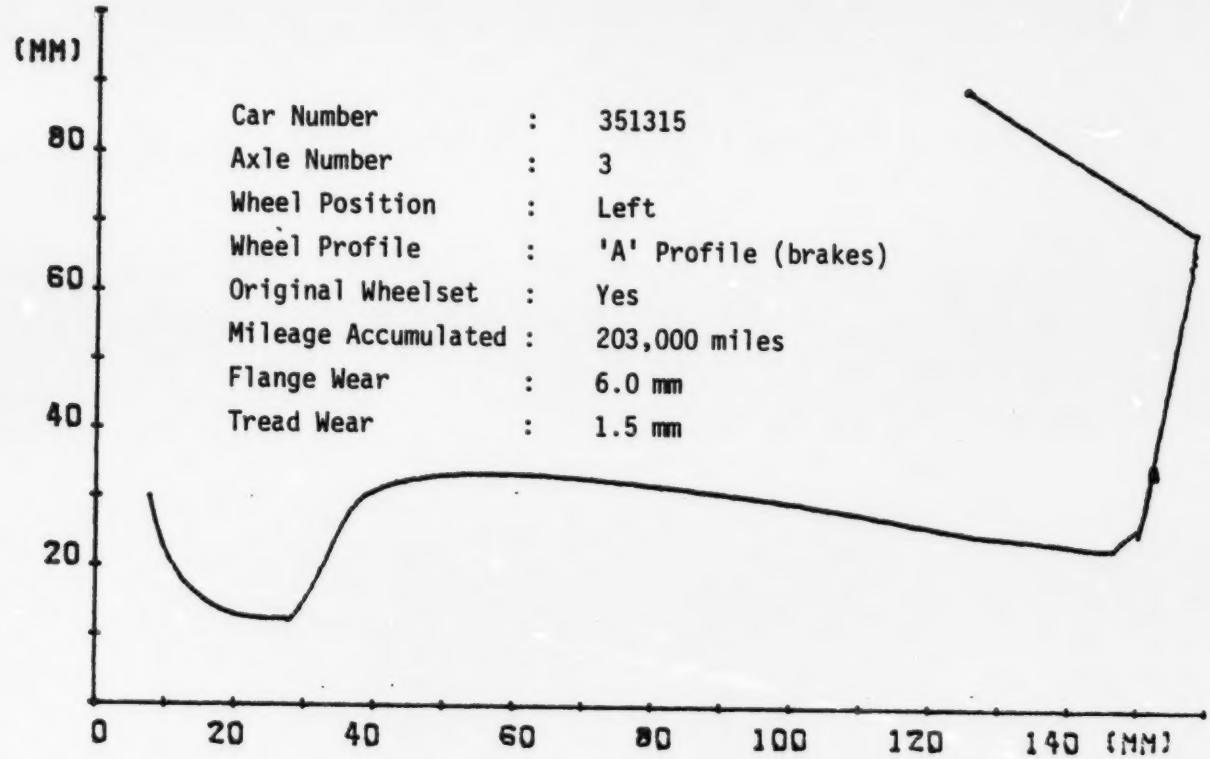
FILE: W0F ID: 904210



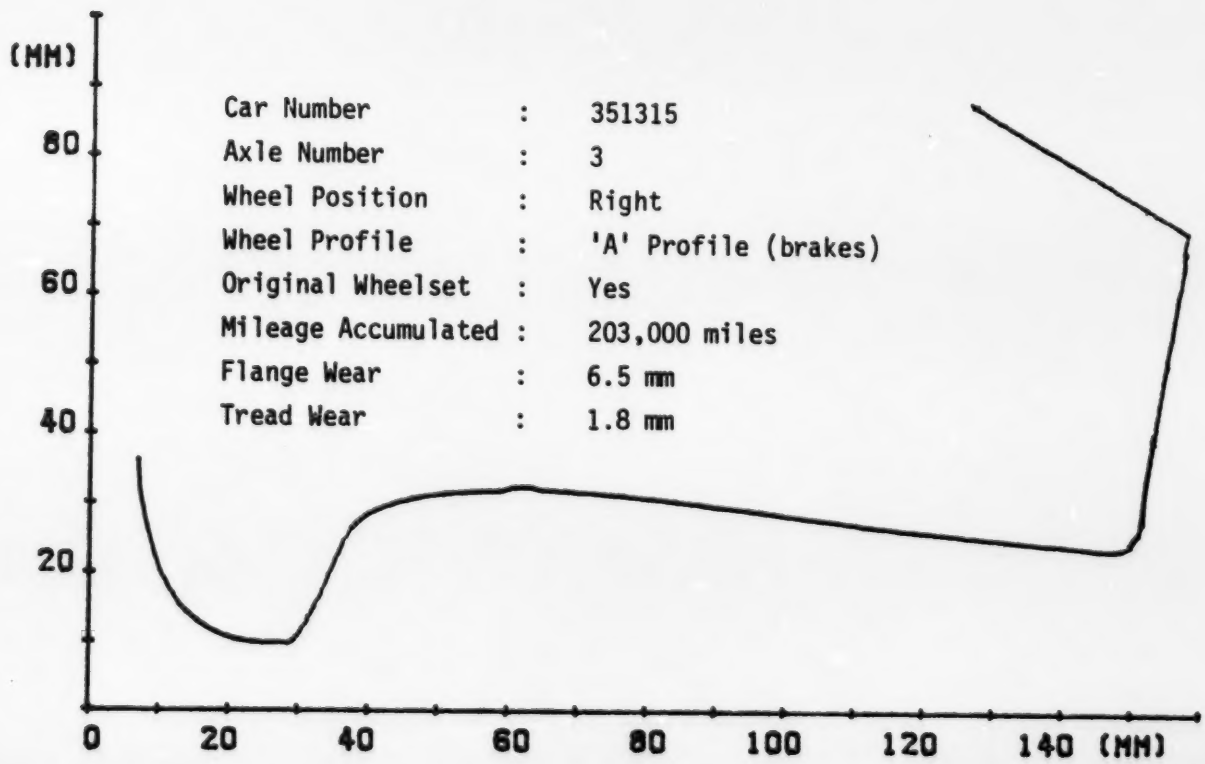
FILE: W0F ID: 904200



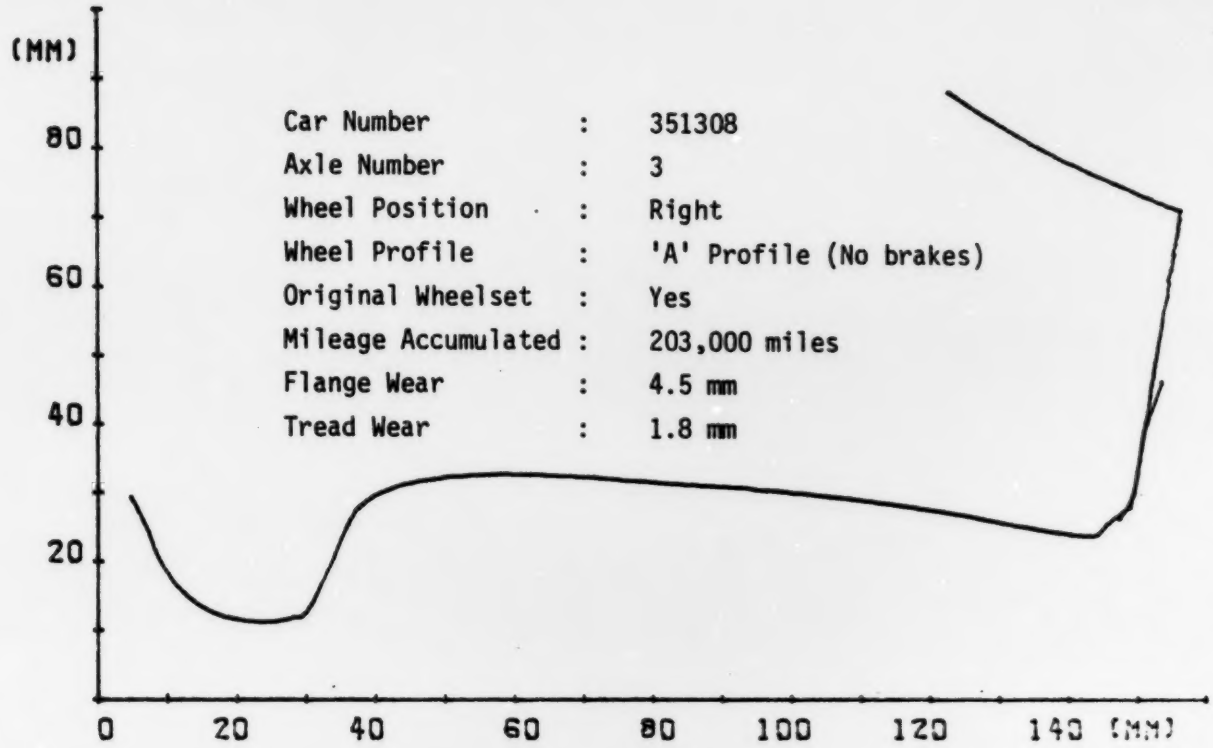
FILE: WOF ID: 901310



FILE: WOF ID: 901300

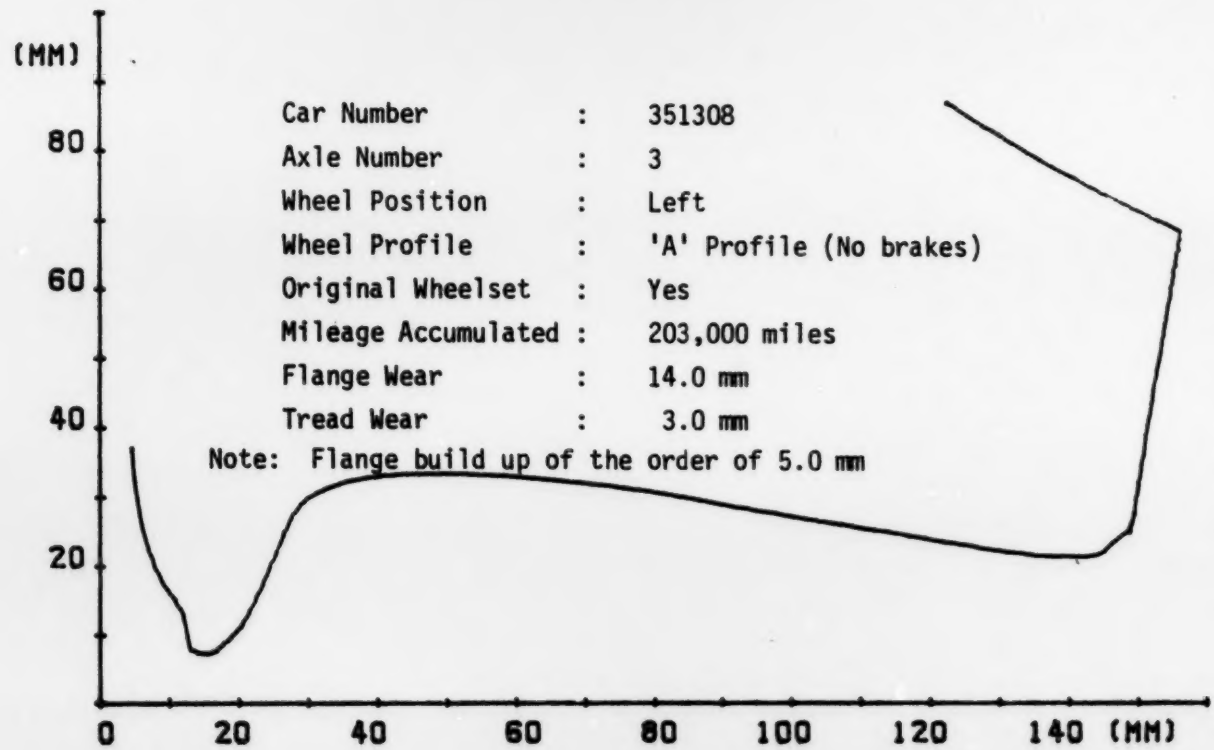


FILE: W0F ID: 902300



Car Number	:	351308
Axle Number	:	3
Wheel Position	:	Right
Wheel Profile	:	'A' Profile (No brakes)
Original Wheelset	:	Yes
Mileage Accumulated	:	203,000 miles
Flange Wear	:	4.5 mm
Tread Wear	:	1.8 mm

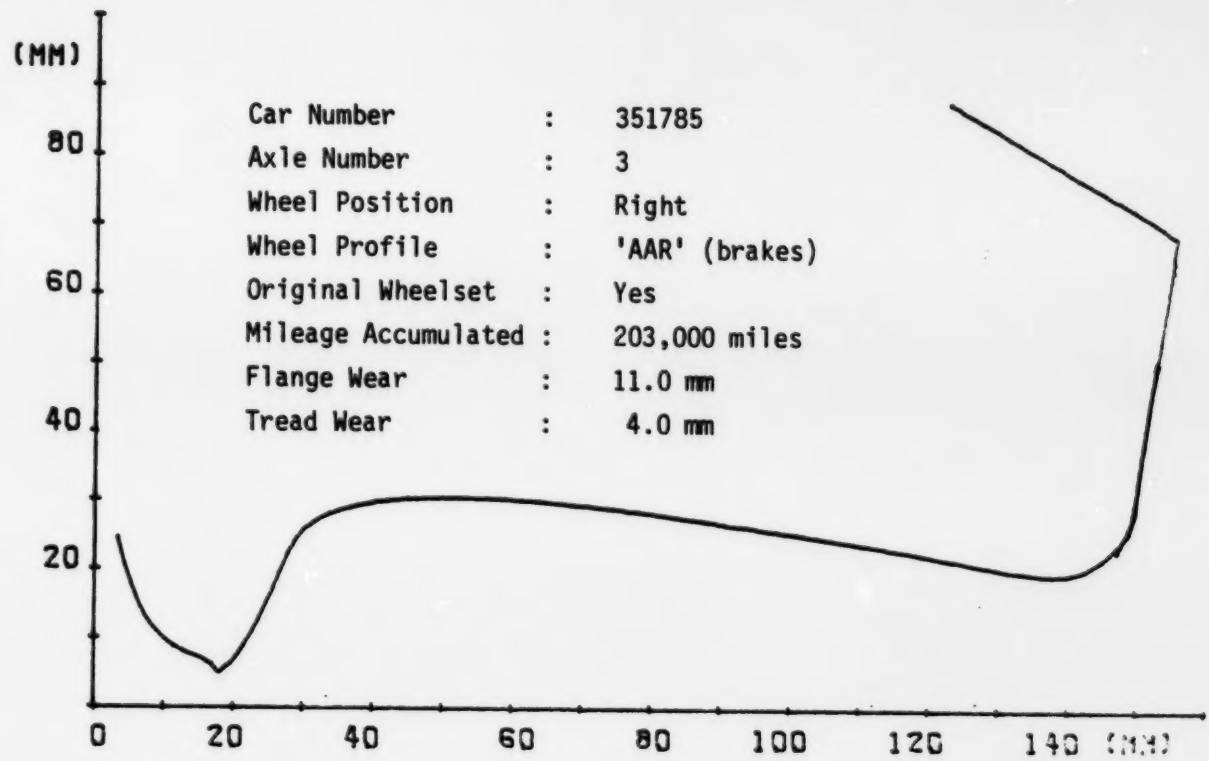
FILE: W0F ID: 902310



Car Number	:	351308
Axle Number	:	3
Wheel Position	:	Left
Wheel Profile	:	'A' Profile (No brakes)
Original Wheelset	:	Yes
Mileage Accumulated	:	203,000 miles
Flange Wear	:	14.0 mm
Tread Wear	:	3.0 mm

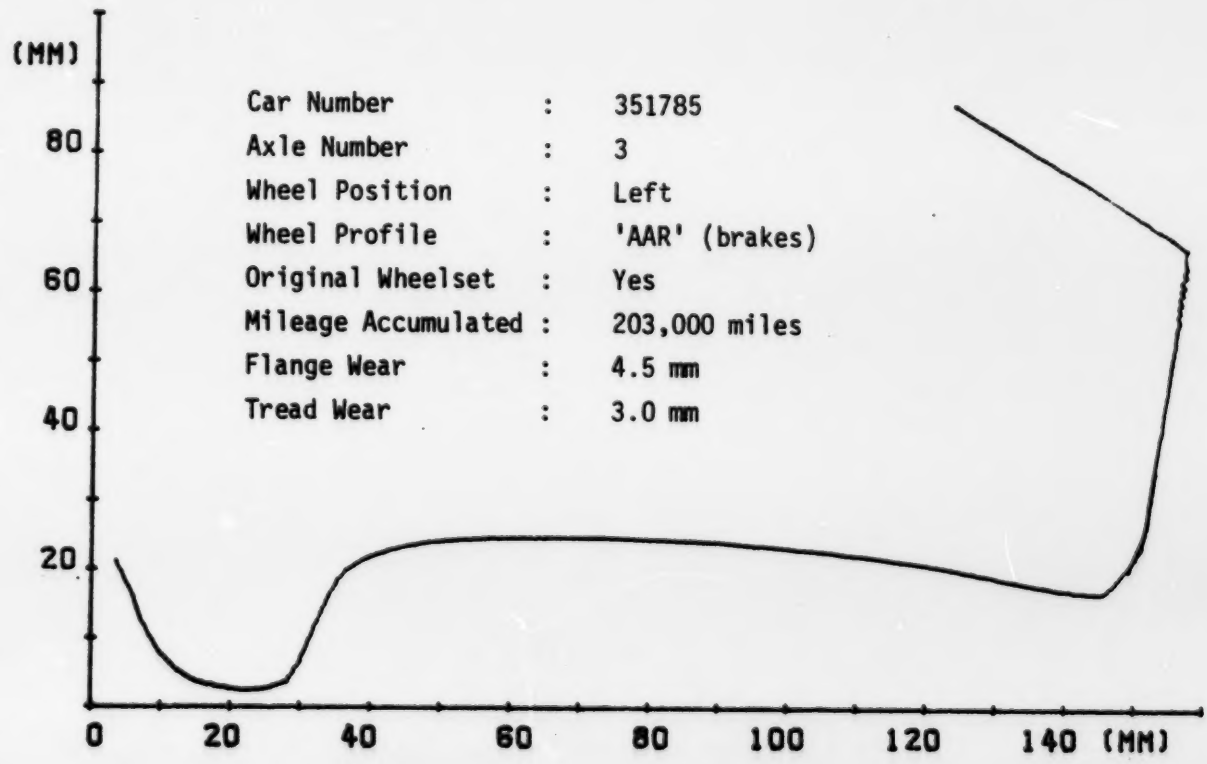
Note: Flange build up of the order of 5.0 mm

FILE: WOF ID: 903300



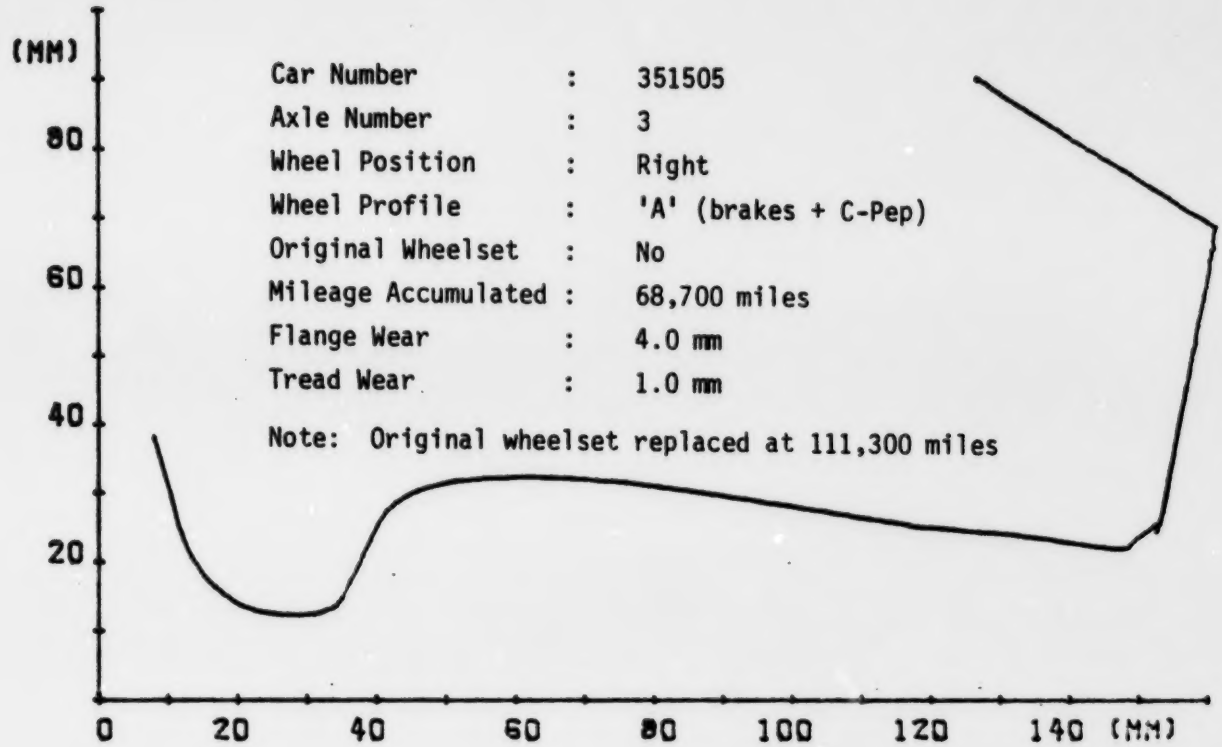
Car Number	:	351785
Axle Number	:	3
Wheel Position	:	Right
Wheel Profile	:	'AAR' (brakes)
Original Wheelset	:	Yes
Mileage Accumulated	:	203,000 miles
Flange Wear	:	11.0 mm
Tread Wear	:	4.0 mm

FILE: WOF ID: 903310



Car Number	:	351785
Axle Number	:	3
Wheel Position	:	Left
Wheel Profile	:	'AAR' (brakes)
Original Wheelset	:	Yes
Mileage Accumulated	:	203,000 miles
Flange Wear	:	4.5 mm
Tread Wear	:	3.0 mm

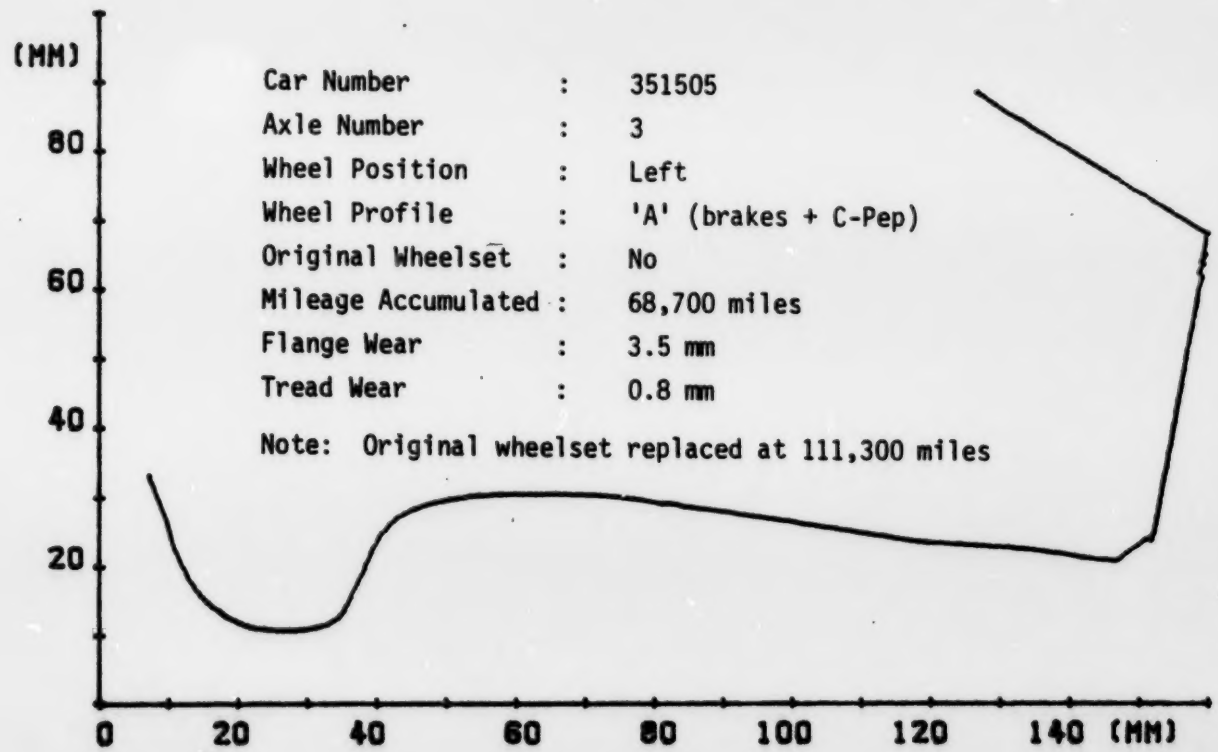
FILE: WOF ID: 904300



Car Number	:	351505
Axle Number	:	3
Wheel Position	:	Right
Wheel Profile	:	'A' (brakes + C-Pep)
Original Wheelset	:	No
Mileage Accumulated	:	68,700 miles
Flange Wear	:	4.0 mm
Tread Wear	:	1.0 mm

Note: Original wheelset replaced at 111,300 miles

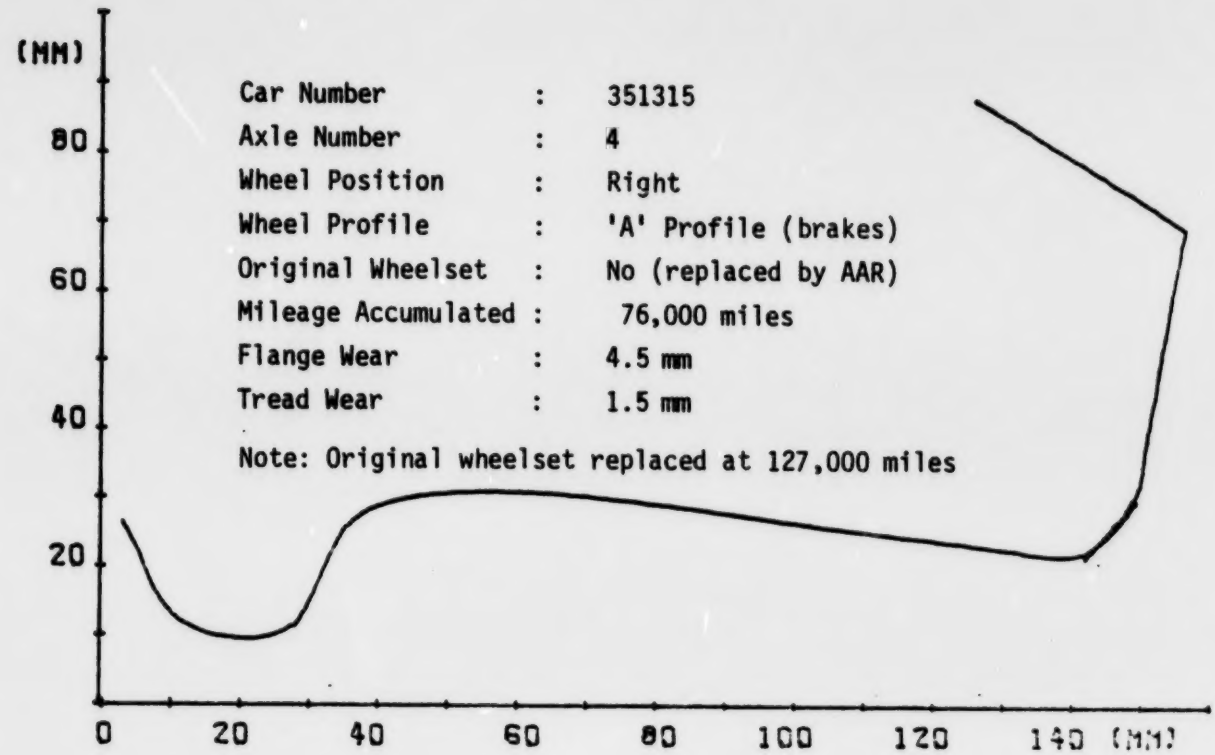
FILE: WOF ID: 904310



Car Number	:	351505
Axle Number	:	3
Wheel Position	:	Left
Wheel Profile	:	'A' (brakes + C-Pep)
Original Wheelset	:	No
Mileage Accumulated	:	68,700 miles
Flange Wear	:	3.5 mm
Tread Wear	:	0.8 mm

Note: Original wheelset replaced at 111,300 miles

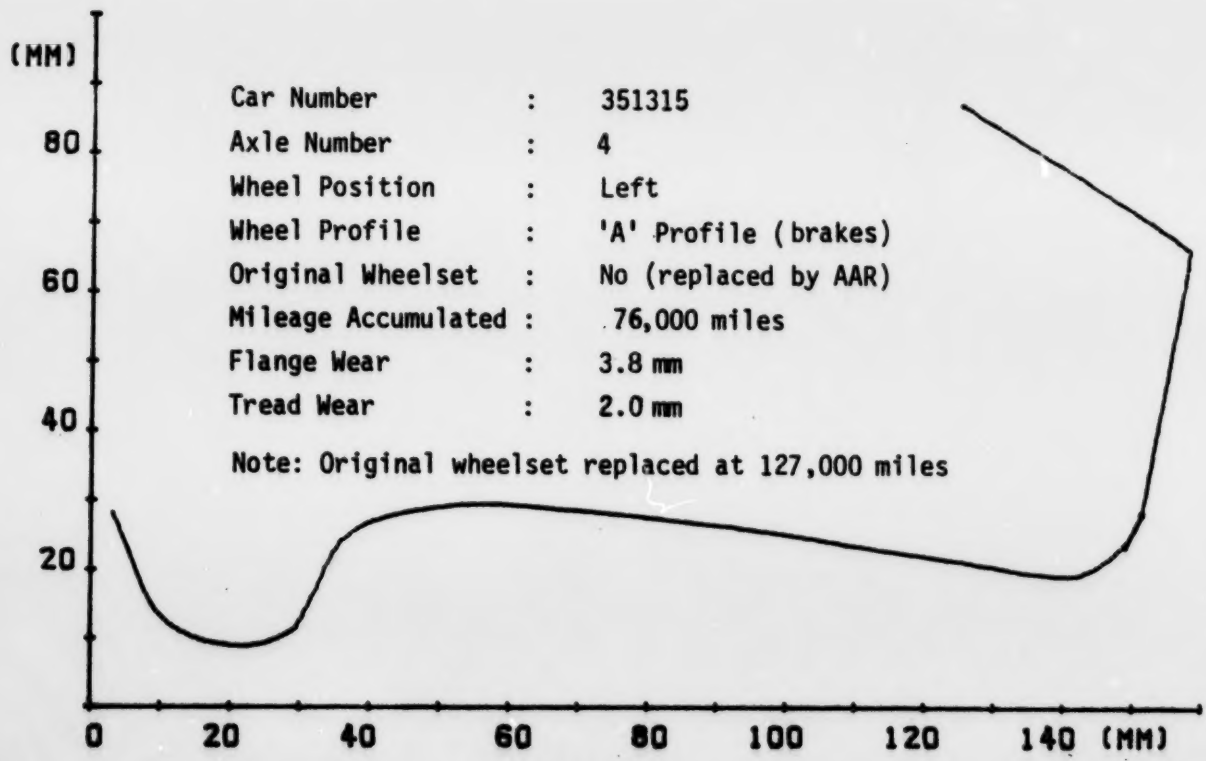
FILE: WOF ID: 901400



Car Number	:	351315
Axle Number	:	4
Wheel Position	:	Right
Wheel Profile	:	'A' Profile (brakes)
Original Wheelset	:	No (replaced by AAR)
Mileage Accumulated	:	76,000 miles
Flange Wear	:	4.5 mm
Tread Wear	:	1.5 mm

Note: Original wheelset replaced at 127,000 miles

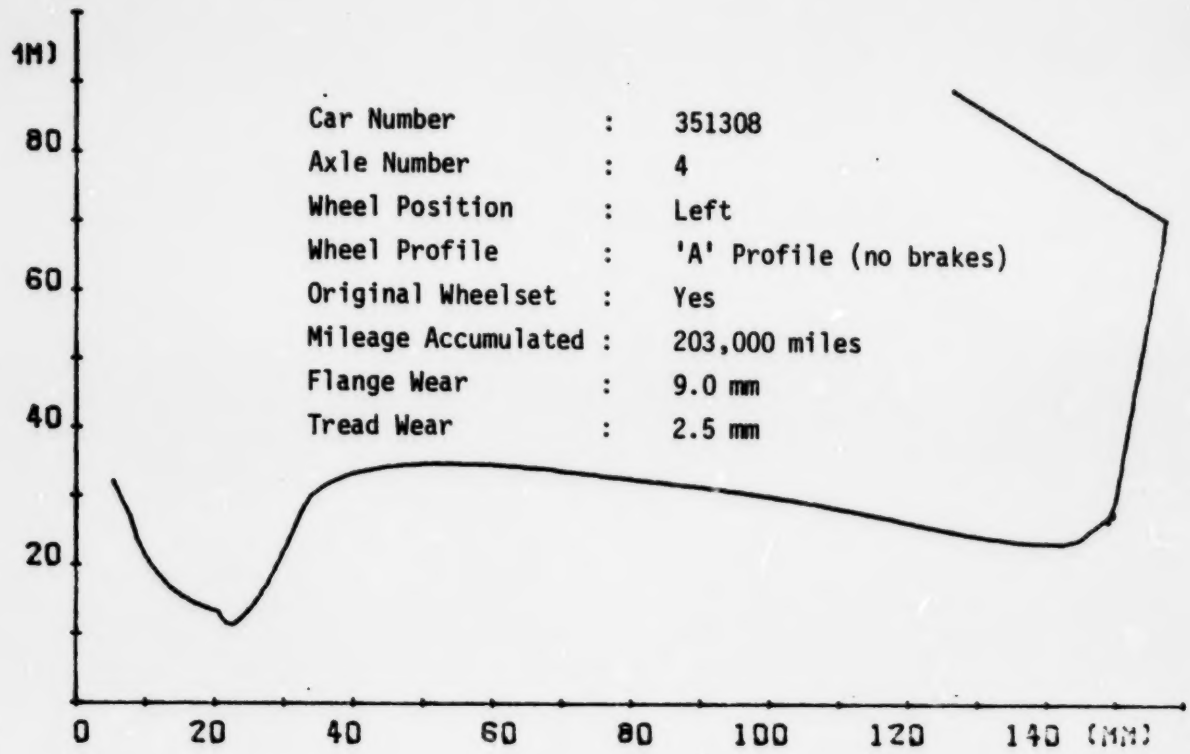
FILE: WOF ID: 901410



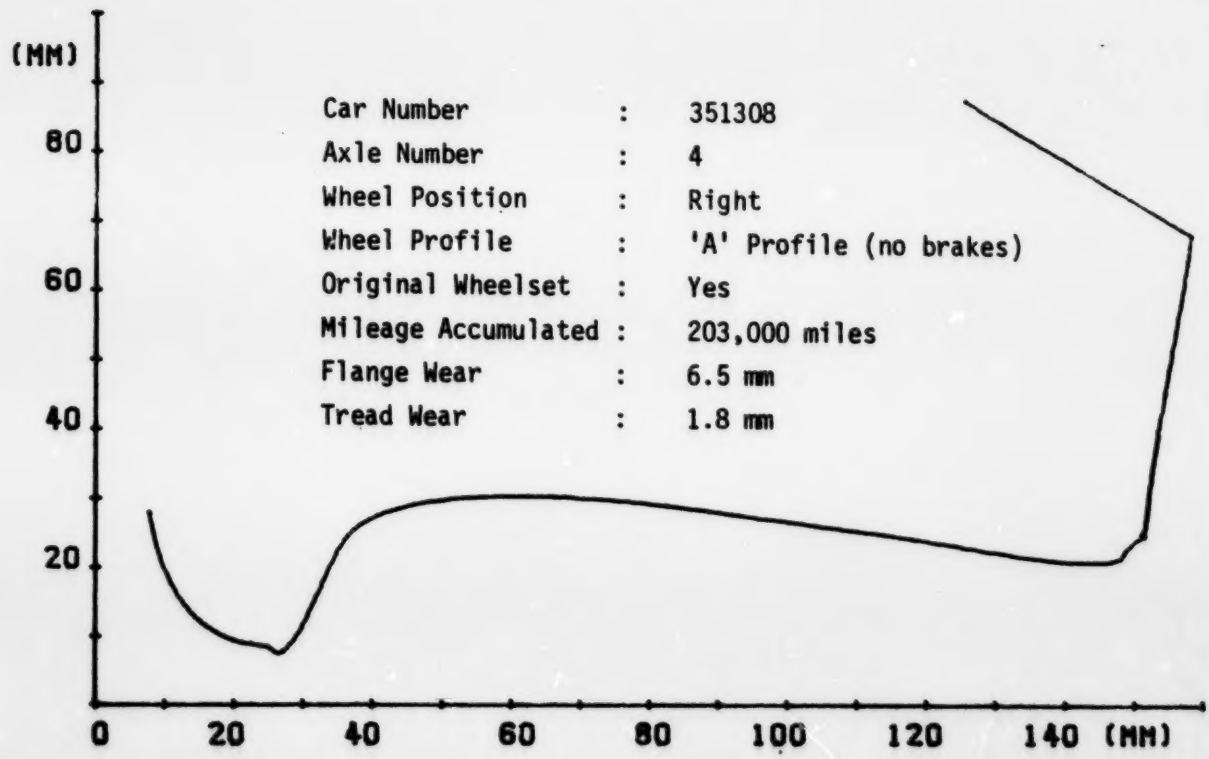
Car Number	:	351315
Axle Number	:	4
Wheel Position	:	Left
Wheel Profile	:	'A' Profile (brakes)
Original Wheelset	:	No (replaced by AAR)
Mileage Accumulated	:	76,000 miles
Flange Wear	:	3.8 mm
Tread Wear	:	2.0 mm

Note: Original wheelset replaced at 127,000 miles

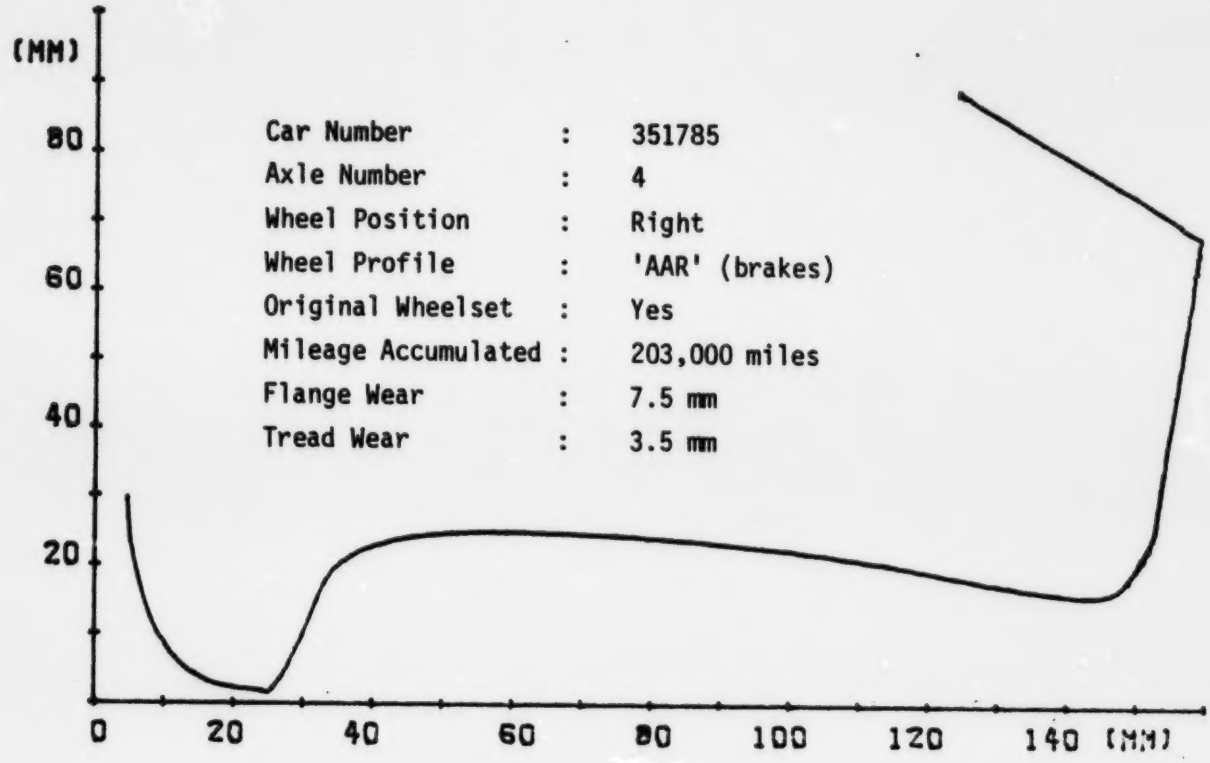
FILE: WOF ID: 902410



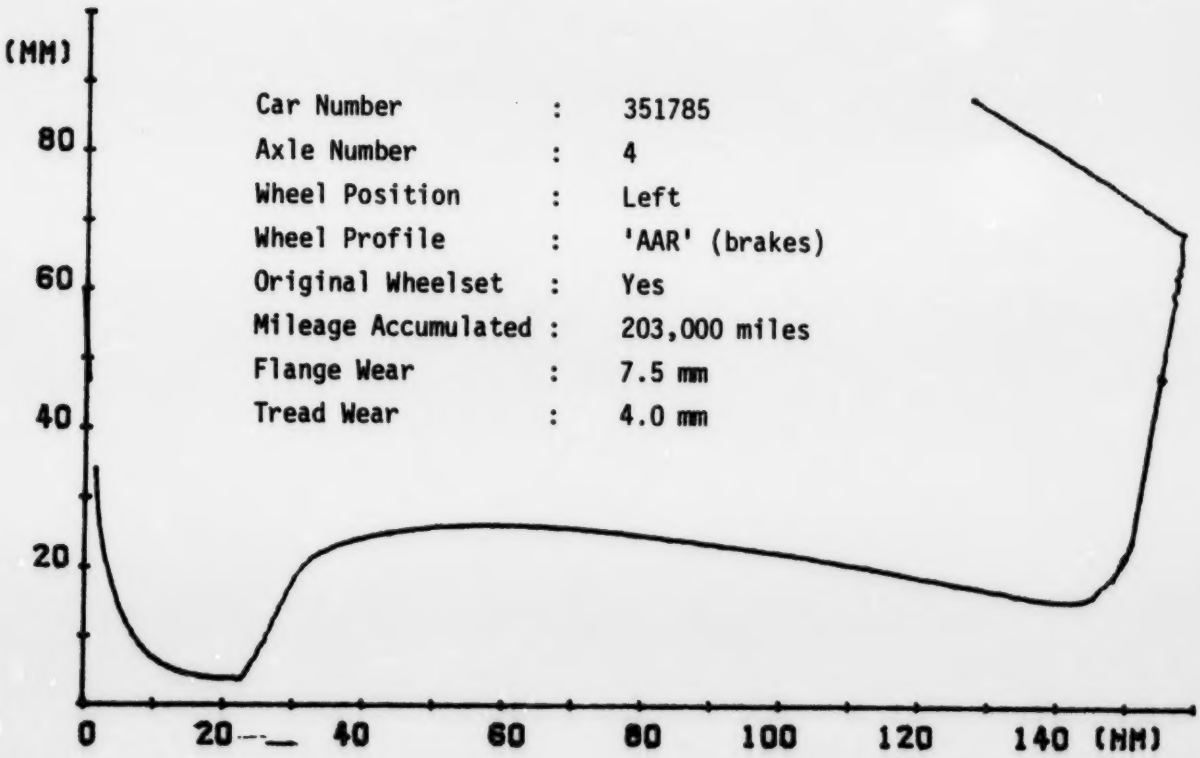
FILE: W3F ID: 902400



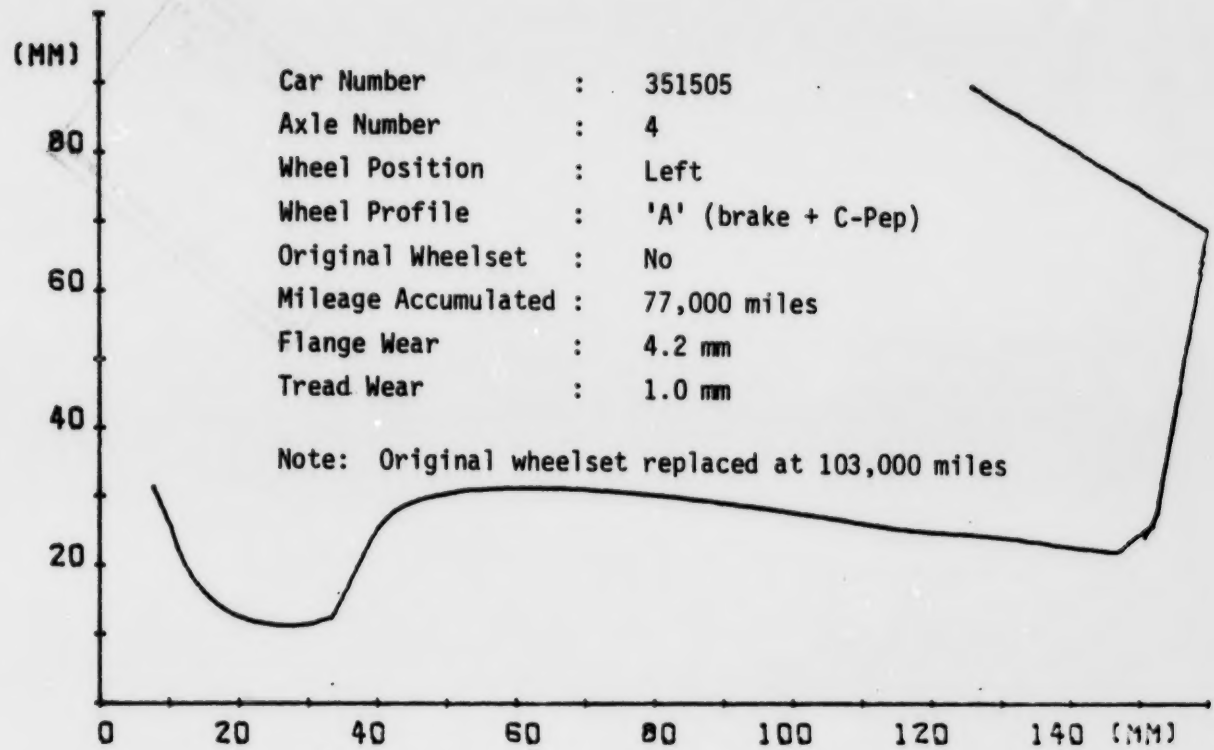
FILE: WOF ID: 903400



FILE: WOF ID: 903410



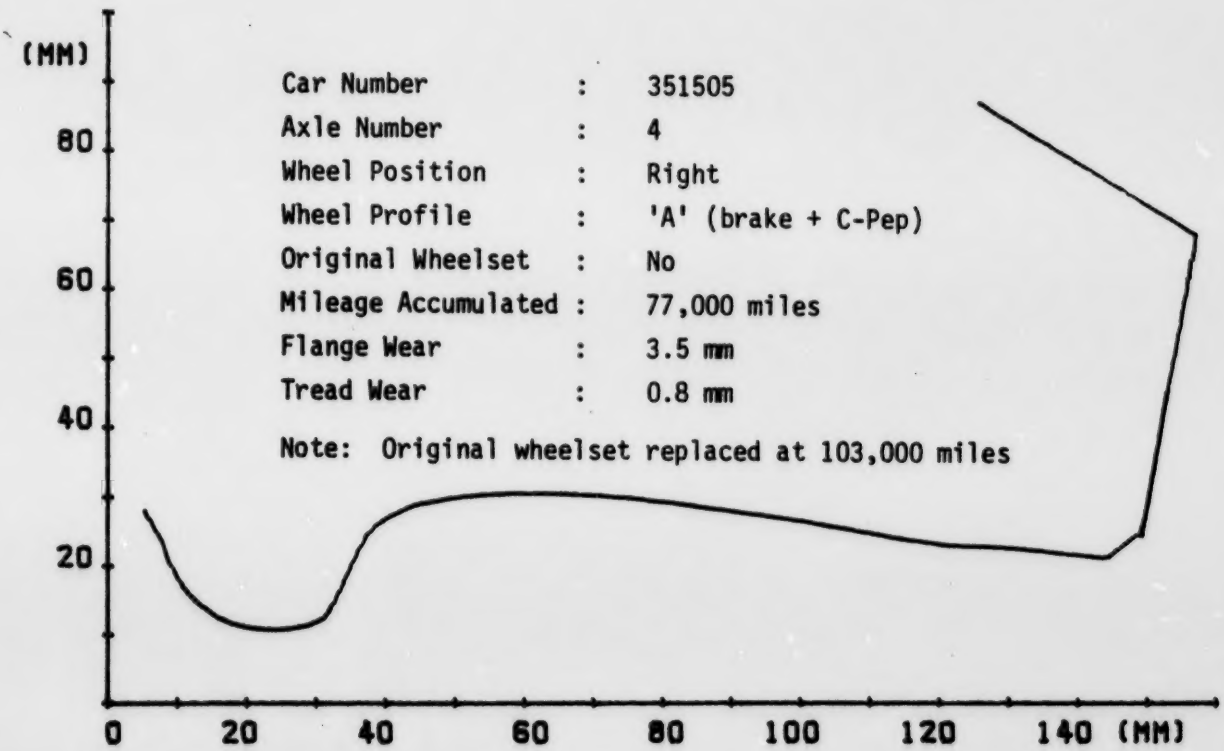
FILE: WOF ID: 904410



Car Number	:	351505
Axle Number	:	4
Wheel Position	:	Left
Wheel Profile	:	'A' (brake + C-Pep)
Original Wheelset	:	No
Mileage Accumulated	:	77,000 miles
Flange Wear	:	4.2 mm
Tread Wear	:	1.0 mm

Note: Original wheelset replaced at 103,000 miles

FILE: WOF ID: 904400



Car Number	:	351505
Axle Number	:	4
Wheel Position	:	Right
Wheel Profile	:	'A' (brake + C-Pep)
Original Wheelset	:	No
Mileage Accumulated	:	77,000 miles
Flange Wear	:	3.5 mm
Tread Wear	:	0.8 mm

Note: Original wheelset replaced at 103,000 miles